



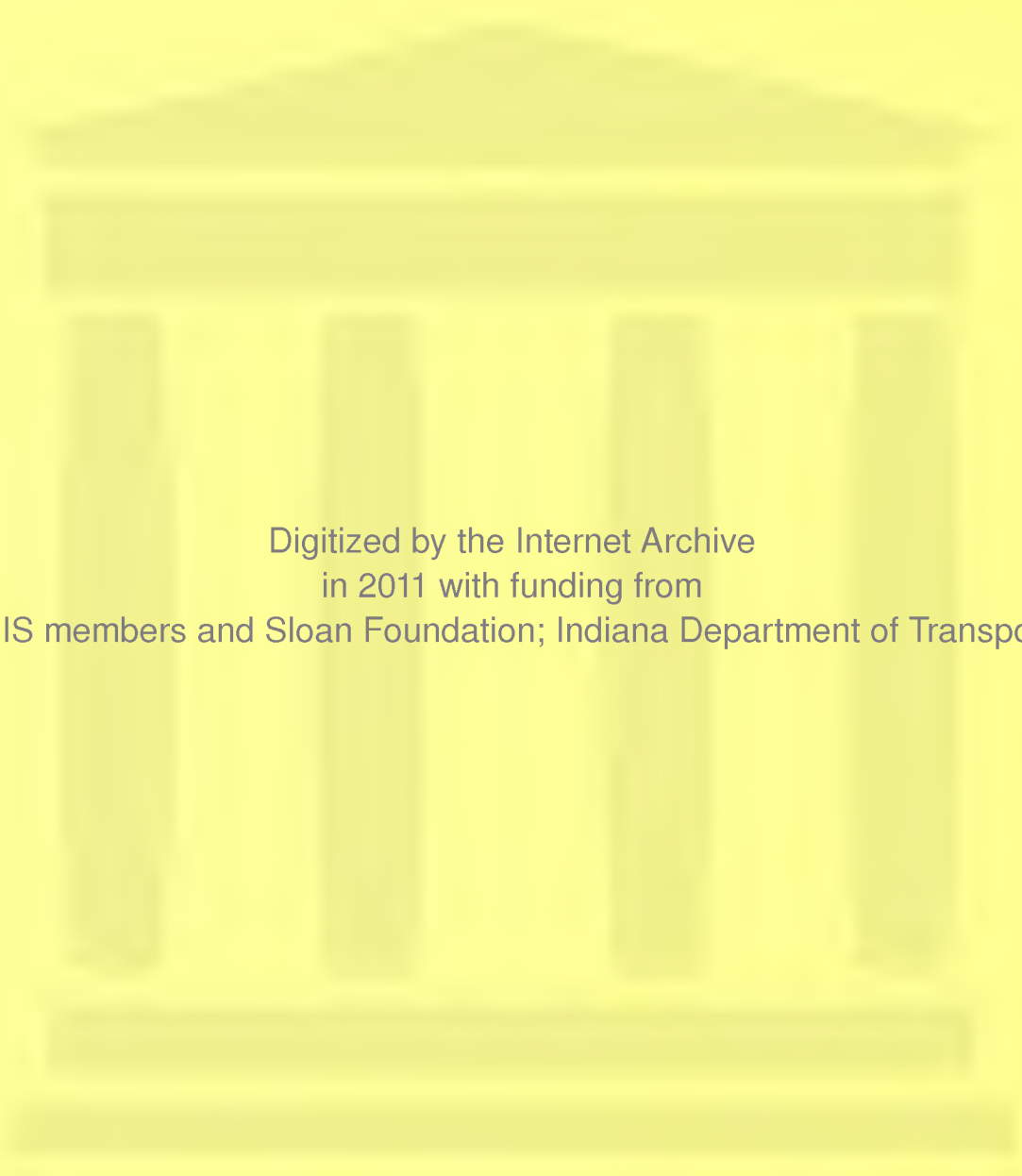
JOINT HIGHWAY RESEARCH PROJECT

JHRP-78-18

A MULTIDISCIPLINARY TEAM
STUDY OF HIGH ACCIDENT
LOCATIONS

J. R. Ogren





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Interim Report

A MULTIDISCIPLINARY TEAM STUDY OF HIGH ACCIDENT LOCATIONS

TO: Harold L. Michael, Director
Joint Highway Research Project

October 3, 1978

File: 8-5-24

FROM: Robert D. Miles, Research Engineer
Joint Highway Research Project

Project: C-36-59X

Attached is an Interim Report on the Indiana HPR Part II study titled "Evaluation of Design and Control Alternatives to Improve Safety of Intersections of Multilane Highways with Other Highways". The title of the report is "A Multidisciplinary Team Study of High Accident Locations". It has been authored by Mr. James R. Ogren under the direction of Professor Robert D. Miles, Research Engineer.

This research developed a multidisciplinary team approach to aid in the alleviation of high accident locations by identifying the predominant accident types and causal factors and by suggesting possible countermeasures. A manual was developed that describes the goals, objectives, organization and field procedure for multidisciplinary team investigation of high accident locations.

The report is forwarded for review, comment and acceptance as partial fulfillment of the objectives of the research. Following presentation to the JHRP Board it will be forwarded for review and acceptance by ISHC and FHWA.

Respectfully submitted,

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16. Abstract <p>This research developed a multidisciplinary team approach to investigate high accident locations to identify the predominant accident types and causal factors and to suggest possible countermeasures. Four teams--each consisting of an ISHC central office traffic engineer, an ISHC district traffic engineer, a local traffic engineer, a human factors person and a law enforcement officer--were organized. The data required for a field investigation by such team members of eighteen high accident sites was developed.</p> <p>A manual was developed that briefly describes the goals and objectives of the multidisciplinary team investigation, prescribes the professional disciplines to be involved, and outlines a procedure for the members to follow in their field investigation. Each member individually drives all approaches to the sites, reviews the data packages supplied, and identifies the accident types and causal factors and suggests possible countermeasures. After all five members return their evaluation forms and the team leader has summarized the results, the team may meet to discuss the results and reach a consensus opinion or the team leader may determine the consensus opinion.</p> <p>The multidisciplinary team approach proved to be effective in developing possible countermeasures to alleviate high accident locations in the State of Indiana.</p>			
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Interim Report
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Engineering Experiment Station
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in cooperation with the
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and the

U.S. Department of Transportation
Federal Highway Administration

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Purdue University
West Lafayette, Indiana
October 3, 1978

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HIGHLIGHT SUMMARY

This research developed a multidisciplinary team approach to aid in the alleviation of high accident locations by identifying the predominant accident types and causal factors and by suggesting possible countermeasures. Four teams--each consisting of an Indiana State Highway Commission (ISHC) central office traffic engineer, an ISHC district traffic engineer, a local traffic engineer, a human factors person and a law enforcement officer--were organized and tested at eighteen sites for effectiveness. The field data required for a field investigation by such team members of high accident sites was developed.

A manual was also developed that briefly describes the goals and objectives of the multidisciplinary team investigation, prescribes the professional disciplines to be involved, and outlines a procedure for the members to follow in their field investigation. Each member in the field procedure individually drives all approaches to the sites, reviews the data packages supplied, and then identifies the accident types and causal factors and suggests possible countermeasures. After all five members return their evaluation forms and the team leader has summarized the results, the team may meet to discuss the results and reach a consensus opinion or the team leader may determine the consensus opinion.

The multidisciplinary team approach proved to be effective in developing possible countermeasures to alleviate high accident locations in the State of Indiana. The results at five intersections are briefly discussed.

CHAPTER I: INTRODUCTION

Traffic accidents are a major concern to the public. It almost seems that every driver at some time in his life has at least one auto accident. In addition, every driver is acquainted with someone who has either died or been seriously injured in an auto accident.

Nationally in 1976, there were 40,600 fatal traffic accidents which resulted in 46,700 deaths. There were also 1,800,000 disabling injuries as a result of 1,200,000 personal injury accidents. In 1976, Indiana had 1262 traffic fatalities (1).

Accidents are sometimes chance events but certain locations on the transportation system have a high frequency of accidents. High accident locations usually have some factors incorporated in them that contribute to accidents. These factors need to be discovered and resolved. Roadway intersections particularly are roadway sites of high accident rates.

Perceiving this massive loss of life and occurrence of personal injuries because of traffic accidents, it was decided to undertake a research project that would attempt to evaluate high accident intersections in Indiana by three techniques:

1. regression analysis between accident rates and roadway design and traffic engineering features
2. multidisciplinary team study of high accident locations to identify prominent accident types and causal factors and recommend possible countermeasures

3. simulation of countermeasures to evaluate effectiveness

The first phase of this research was investigated by Peter A. Van Maren (35). The results of his regression analysis showed that for unsignalized intersections with stop control on the minor roadway the factors that are highly correlated with accident rates are:

- 1) danger distance (the distance across the intersection)
- 2) the presence of a median barrier
- 3) stop sign size

At high accident signalized intersections, the factors highly correlated with accident rates are:

- 1) the absence of stop lines
- 2) the absence of advance warning signs
- 3) horizontal curves
- 4) intersection skew

The subject of this research, the second phase of the three phase project, is the multidisciplinary team study of high accident locations. A working definition of a multidisciplinary team is a group of people from various disciplines using their various degrees of experience and knowledge to form a consensus opinion in this study on the causal factors and methods of correction of high accident locations. The results and analysis of the organization of the teams as well as their evaluation will be presented.

The third phase involves analyzing different countermeasures for high accident locations using a computer simulation package. Reports on this phase are to be submitted separately.

Accidents seldom occur simply because of any single causal factor; usually more than one factor interacts with others. These factors may relate to the roadway, the driver or the vehicle and their combinations. Of these three elements, the most easily controlled is the roadway since it can be physically changed or redesigned. The driver and vehicle are not as easily controlled. This is not to say that they should not be considered. Laws regulate the minimum standards for acquiring a driver's license and for vehicle inspection but there is no absolute control of the driver or the vehicle when operated on the roadway.

The Institute for Research in Public Safety at Indiana University in an in-depth study of accidents found that the percentage of accidents attributable to vehicle failures was six percent or greater (18). Brake system failures followed by tires and wheels, communication systems and steering systems were implicated in most accidents. The study also showed that accidents are due to driver error (73 percent or greater) and inadequacies in roadway design (15 percent or greater). Of the driver errors, decision errors and recognition errors were most often suggested. Specific driver errors were listed as improper look-out, improper evasive action, excessive speed, and inattention. View obstructions and slick pavements were implicated most often as roadway inadequacies (18). It is then the driver and roadway design that should be the most promising when proposing countermeasures to alleviate high accident locations.

Traditionally, high accident site analysis is conducted by the governmental traffic engineering office with dominion over the roadway. An in-house traffic engineer, an engineering review committee, or a

field investigating team is responsible for the actual site investigation if one is conducted. The high accident site is viewed often only from the highway and/or traffic engineering standpoint. The engineer's concern is mainly with the roadway characteristics, i.e., the roadway geometrics, the signing characteristics and possible obstructions. The driver's aspect in this evaluation process is considered relative to sign distance, visibility and matters of this nature.

A more complete input of the driver's aspect might be obtained using a multidisciplinary team approach to develop countermeasures for high accident locations. This could be accomplished by involving other than engineering disciplines, for example a human factors person and a law enforcement officer, in the team investigation. Inclusion of such members also should increase the awareness of other members to the driver element. A more diversified and complete perspective might then be taken of problem locations. Although the traffic engineering organization is usually responsible for the final decision on what specific countermeasures to implement, such a multidisciplinary team should be able to offer valuable input.

Purpose

The purpose of this research was to develop and implement a procedure by which a multidisciplinary team could suggest possible causal factors and countermeasures for specific accident types. The procedure was developed for the Indiana State Highway Commission (ISHC) and is applicable to high accident locations.

At the beginning of this research, the following tasks were outlined:

1. Conduct a literature search of multidisciplinary teams and their application to accident studies.
2. Determine the size, the professional disciplines and organization of teams to evaluate high accident locations.
3. Develop a manual to guide the team members in the field investigation and the evaluation of the high accident locations.
4. Evaluate the multidisciplinary team approach relative to the analysis of high accident locations.
5. Prepare a final report of the multidisciplinary team investigation of high accident locations to include a procedural manual for site analysis.

Scope

This research applied the developed multidisciplinary team technique to high accident locations on the state primary system. Specific sites were designated by traffic engineers of the ISHC and are listed in Table 1. The geographical locations of these high accident sites in Indiana are shown in Figure 1. Originally, there were nineteen sites with twenty-three intersections. Three of these sites, however, had to be dropped from consideration. The deficiencies causing their elimination were discovered during the collection of the field data. The three sites eliminated were US 31 at SR 28, US 30 at Burr Street and I-465 at Emerson Avenue. The intersections of US 31 at SR 28 and US 30 at Burr Street had undergone recent substantial changes in design. The intersection of I-465 at Emerson Avenue was found to have no accident problem.

Sixteen sites involving eighteen intersections were studied. Two sites were interchanges, one diamond and the other a partial cloverleaf

Table 1
List of Designated High Accident Locations

<u>Site No.</u>	<u>Location</u>	<u>County</u>	<u>ISHC District</u>
1	SR 63 at SR 163	Vermillion	Crawfordsville
2	SR 37 at SR 450	Lawrence	Vincennes
3	US 24 By-pass at SR 5	Huntington	Fort Wayne
4	US 31 at SR 18	Miami	Fort Wayne
5	SR 37 at SR 48	Monroe	Seymour
6	SR 39 at SR 67(S.Jct.)	Morgan	Seymour
7	SR 37 at SR 252	Morgan	Seymour
8	US 31 at SR 14	Fulton	LaPorte
9	US 41 at 45th Ave.	Lake	LaPorte
10	US 31 at Kern Rd.	St. Joseph	LaPorte
11	US 31 at SR 38	Hamilton	Greenfield
12	US 40 at Round Barn Rd.	Wayne	Greenfield
13	US 31 at National Ave.	Marion	Greenfield
14	SR 67 at Franklin Rd.	Marion	Greenfield
15	SR 67 at I-465(2)(NE)	Marion	Greenfield
16	SR 67 at I-465(2)(SW)	Marion	Greenfield

Table 1

List of Designated High Altitude Locations

Site No.	Location	Altitude	Remarks
1	7500 ft. to 10,000 ft.	10,000 ft.	High altitude
2	10,000 ft. to 12,000 ft.	12,000 ft.	High altitude
3	12,000 ft. to 14,000 ft.	14,000 ft.	High altitude
4	14,000 ft. to 16,000 ft.	16,000 ft.	High altitude
5	16,000 ft. to 18,000 ft.	18,000 ft.	High altitude
6	18,000 ft. to 20,000 ft.	20,000 ft.	High altitude
7	20,000 ft. to 22,000 ft.	22,000 ft.	High altitude
8	22,000 ft. to 24,000 ft.	24,000 ft.	High altitude
9	24,000 ft. to 26,000 ft.	26,000 ft.	High altitude
10	26,000 ft. to 28,000 ft.	28,000 ft.	High altitude
11	28,000 ft. to 30,000 ft.	30,000 ft.	High altitude
12	30,000 ft. to 32,000 ft.	32,000 ft.	High altitude
13	32,000 ft. to 34,000 ft.	34,000 ft.	High altitude
14	34,000 ft. to 36,000 ft.	36,000 ft.	High altitude
15	36,000 ft. to 38,000 ft.	38,000 ft.	High altitude
16	38,000 ft. to 40,000 ft.	40,000 ft.	High altitude
17	40,000 ft. to 42,000 ft.	42,000 ft.	High altitude
18	42,000 ft. to 44,000 ft.	44,000 ft.	High altitude
19	44,000 ft. to 46,000 ft.	46,000 ft.	High altitude
20	46,000 ft. to 48,000 ft.	48,000 ft.	High altitude
21	48,000 ft. to 50,000 ft.	50,000 ft.	High altitude
22	50,000 ft. to 52,000 ft.	52,000 ft.	High altitude
23	52,000 ft. to 54,000 ft.	54,000 ft.	High altitude
24	54,000 ft. to 56,000 ft.	56,000 ft.	High altitude
25	56,000 ft. to 58,000 ft.	58,000 ft.	High altitude
26	58,000 ft. to 60,000 ft.	60,000 ft.	High altitude
27	60,000 ft. to 62,000 ft.	62,000 ft.	High altitude
28	62,000 ft. to 64,000 ft.	64,000 ft.	High altitude
29	64,000 ft. to 66,000 ft.	66,000 ft.	High altitude
30	66,000 ft. to 68,000 ft.	68,000 ft.	High altitude
31	68,000 ft. to 70,000 ft.	70,000 ft.	High altitude
32	70,000 ft. to 72,000 ft.	72,000 ft.	High altitude
33	72,000 ft. to 74,000 ft.	74,000 ft.	High altitude
34	74,000 ft. to 76,000 ft.	76,000 ft.	High altitude
35	76,000 ft. to 78,000 ft.	78,000 ft.	High altitude
36	78,000 ft. to 80,000 ft.	80,000 ft.	High altitude
37	80,000 ft. to 82,000 ft.	82,000 ft.	High altitude
38	82,000 ft. to 84,000 ft.	84,000 ft.	High altitude
39	84,000 ft. to 86,000 ft.	86,000 ft.	High altitude
40	86,000 ft. to 88,000 ft.	88,000 ft.	High altitude
41	88,000 ft. to 90,000 ft.	90,000 ft.	High altitude
42	90,000 ft. to 92,000 ft.	92,000 ft.	High altitude
43	92,000 ft. to 94,000 ft.	94,000 ft.	High altitude
44	94,000 ft. to 96,000 ft.	96,000 ft.	High altitude
45	96,000 ft. to 98,000 ft.	98,000 ft.	High altitude
46	98,000 ft. to 100,000 ft.	100,000 ft.	High altitude

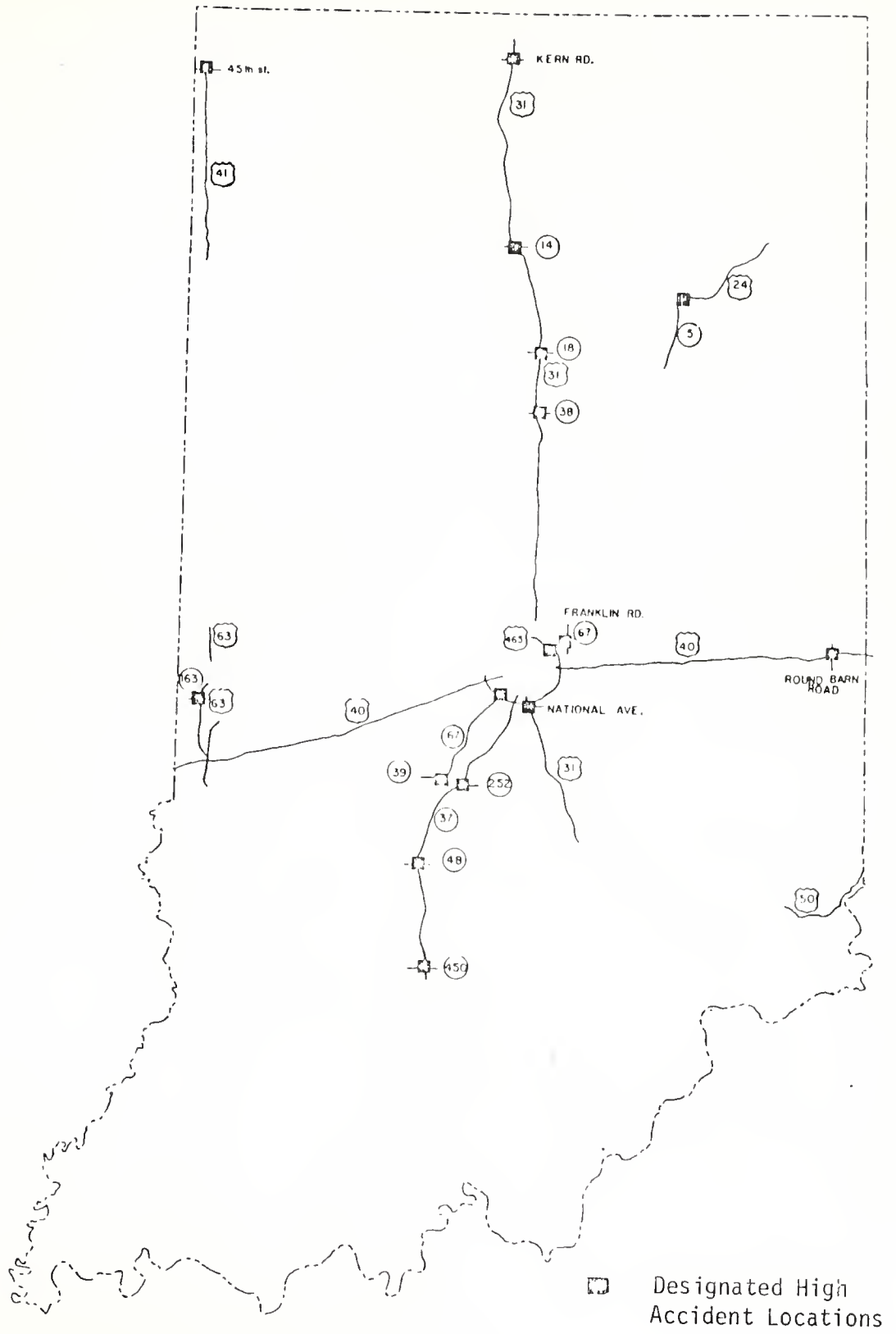


Figure 1. Geographical Location of Designated High Accident Locations

in adjacent quadrants. Each interchange was considered to be two intersections where the off-ramps meet the crossroad. On the other fourteen sites, the major route was usually a US highway or State road whereas the minor road was a State road, a county road or suburban street. The geometrical design of these locations ranged from a four-lane undivided highway intersecting a two-lane county road to a four-lane divided highway with a fifty foot median and a full set of acceleration and deceleration lanes intersecting a four-lane undivided facility. All of the sites, it should be noted, were in a rural or suburban area. Even though all the high accident sites assigned by the ISHC are intersections, the procedure developed in this research is applicable to all types of roadway locations where high accident rates occur.

The eighteen intersections under study were high accident locations. Over the three years of 1974, 1975, and 1976, there were 1028 accidents at these eighteen locations. Fifteen persons were killed and 572 persons were injured. Thirty-three percent were rear-end accidents, twenty-five percent were right angle accidents and twenty-six percent were left turning movement accidents. Any reduction of accidents, such as might result from an analysis of causal factors and the implementation of countermeasures suggested by multidisciplinary teams who investigated the high accident locations, would be of benefit to the people of the State of Indiana.

CHAPTER II: PREVIOUS INVESTIGATIONS

Data Requirements

Various kinds of data are required to implement an accident study program using the multidisciplinary team approach. Three references that are most beneficial are the Manual of Traffic Engineering Studies (6), The Manual on Identification, Analysis and Correction of High Accident Locations (15) and A User's Guide to Positive Guidance (4). All three references suggest use of condition diagrams, collision diagrams and volume data in accident studies. The two manuals further suggest that speed studies and conflict data also be included. The method of preparation of the suggested data is also included in some of the above references. A minimum of three years of accidents records is desirable.

Team Development

Certain decisions concerning the development of a multidisciplinary team were made on the basis of experience from other team studies. Important questions to be answered were:

1. Is a team decision really better than an individual's opinion?
2. Is it better to have professional persons doing the evaluations, lay persons or both?
3. Is it better to isolate team members or allow interaction between them?

Waag and Halcomb (36) comment that they feel team decisions are definitely superior to individual decisions. They felt that it is preferable for team members to be isolated and allow no interaction between members.

Nakamura (24) developed three panels to rate pavements. Each panel was composed of different members: one with ISHC engineers, one with professors from the Civil Engineering School at Purdue University, and one with randomly chosen lay persons. Each member of each team rated the pavements individually. The author believed that no interaction between team members was best. One of her findings was that there was no significant difference between team ratings. She also noted that the ISHC engineer team tended to be more critical of the pavements than the lay persons panel.

It appears from the literature that team analysis is beneficial in decision making. The best method seems to be to let the members evaluate individually and then combine their results. Even though a professional team decision may be no different than that by a team of lay persons, professional personnel were used in this research because they tend to be more critical and may offer better suggestions for counter-measures.

Multidisciplinary Teams

The documentation of the multidisciplinary team approach in analysis of civil engineering problems is very extensive. There are a number of different kinds of multidisciplinary teams used in the transportation area. Teams have been used in highway corridor and design review, in conducting on-site accident analysis, and in studies in determining

causal factors at accident locations. Different professions and sizes of teams have been used in order to adequately meet the specific objectives and needs of the various studies.

Teams which review highway and transit corridors and their subsequent designs are by far the most prevalent at the state levels and in large cities. This type of team is usually very large and employs very diverse professions. Agarwal (2) feels that there is a real need for multidisciplinary planning teams since the problems found in highway and transit design are complex and one professional discipline is not sufficient to cover the realm of possible considerations. He also suggests that the team besides just looking at the various alternatives also look at the performance characteristics of such alternatives.

At the 57th Annual Meeting of the Transportation Research Board, interdisciplinary teams were spotlighted in Session 48. Representatives from the Federal Highway Administration as well as from four different states discussed in detail the role of the teams, their problems and successes. All thought interdisciplinary teams were a valuable tool in design review and as a step in the transportation planning process.

The multidisciplinary teams reported in the literature (4,7,9,12, 16,23,26) all reviewed designs, suggested alternatives, and made recommendations on the final highway design. Each team involved different professions depending on the project's specific needs. For instance, Milhollin (23) mentions a team using biological and botanical scientists because the highway design section under study was in a rather under-developed area of the Rocky Mountains. These scientists, of course, would not be needed when performing a corridor analysis for a Chicago Cross-town Expressway (26). This type of multidisciplinary team is

often very large and spans a number of professions, consequently it can be very expensive.

The second type of common multidisciplinary team documents on-site accident investigations. These are mainly medical-engineering teams investigating accidents immediately after they happen. They often use a 3 x 3 matrix for their investigation. Along one axis is pre-crash, crash and post-crash conditions and along the other axis is the driver, the auto and the environment. Each cell is filled by any deficiency or possible accident cause discovered. The outcome of this type of team analysis are causal factors of the accidents and specific causal factors of injuries incurred during the accident.

Accident investigation teams usually consist of ten or more people with professions in medicine, psychology, mechanical engineering, civil engineering, and various support personnel. These members do an especially intensive occupant autopsy in cases of fatality and a vehicle autopsy as well (3,5,8,13,32,33,34).

The Proceedings of the Collision Investigation Methodology Symposium (8) is a very significant reference in that it is a state-of-the-art summary on the multidisciplinary accident investigation team concept. It documents the history of the multidisciplinary team concept and explains how different states as well as private and public organizations have used it in the past and continue to use it.

There are two important aspects of this particular type of multidisciplinary team approach. The first is that since the members are investigating the accidents immediately after they occur, someone must monitor a police radio, gather the team together and then investigate

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There are two important aspects of this particular type of multidisciplinary team approach. The first is that since the members are investigating the accidents immediately after they occur, someone must monitor a police radio, gather the team together and then investigate

the accident. This is both time consuming and expensive. Secondly, the results of a team investigation are supposed to be confidential and not to be made available in a court of law. So far, no one has asked for this information thus the legality of the results being confidential has not been established.

The third type of multidisciplinary team currently used deals with the cause of certain types of accidents and develops countermeasures to alleviate the problem area. To date however, only relatively little has been done in this area and none has been reported in the highway engineering literature as pertaining to high accident locations.

Richards, Rowan and Kanak (27) used eight to ten member teams to evaluate railway grade crossings. This team evaluated the safety aspects of railway grade crossings. Schultz (29) felt that team members from governmental organizations at various levels could be used to locate high accident locations.

The review of the literature did not locate any documentation of the use of a multidisciplinary team to evaluate high accident locations and suggest countermeasures to alleviate the problem area. As multidisciplinary team analysis in other areas has proved profitable, its application to high accident locations was a fertile area for research.

CHAPTER III: PROCEDURE DEVELOPMENT

The development of a multidisciplinary team approach to high accident site investigation and a procedure to guide the team in a field investigation lends itself to study in three distinct areas: the team itself, a manual and the procedure prescribed for team operation, and the data required. The ultimate decisions in the development of these areas were based on the literature review, the advice of the advisory committees involved and the researcher's judgment and experience obtained during field application at eighteen high accident locations.

Development of the Team

Certain criteria are considered necessary for a multidisciplinary team to be functionally effective. The first being that the team be small enough so as to be manageable and easily organized yet large enough so that it incorporates all the disciplines desired. Secondly, the professional disciplines should span the areas of both the roadway and driver aspects so as to give a complete perspective of each high accident location. Lastly, the team members should vary in degree of professional experience and familiarity with the accident locations.

The decision as to the number of team members and the disciplines involved are related. From reviewing the literature and considering all criteria, a team size of between three and seven appeared reasonable. To rule out the possibility of a split team decision, an odd number of

members appears desirable. Team sizes could then be three, five or seven. These numbers are all easily organized without too much time or effort expended. A five person team was selected for this research.

The professions involved in the team should be concerned with factors involving the driver as well as factors of the roadway. The five person team, hence was organized as follows. An ISHC central office traffic engineer was selected because of his experience in roadway analysis. An ISHC district traffic engineer and a local traffic engineer were selected because of their different viewpoints and possible familiarity with the high accident sites. To more fully cover the driver aspects of the accident problem, a human factors expert and a local law enforcement officer were employed. This was not the only team configuration considered but the one felt to best fit the needs for high accident locations on Indiana state highways. This five member team fulfills the criteria of a manageable size, incorporates the point of view of both driver and roadway factors in highway accidents, and provides varying degrees of professional experience and familiarity with the intersection locations. It seems appropriate to discuss why each member was chosen, what qualities each member adds to the team, and what additional duties, if any, each was assigned.

The ISHC central office traffic engineer was selected as the team leader for three reasons. The first being that his office designates the specific high accident locations to be investigated and is also the organization that is responsible for recommending the final correction and changes for the problem site. Secondly, this member through his position has easiest access to the traffic information required for the study to be successful. Lastly, he is the logical choice to organize

and direct the team in its investigation. The additional responsibilities of the team leader will be discussed later. Typical desirable qualities of the ISHC central office traffic engineer is that he likely has experience in both geometric design of highway and traffic engineering and has been exposed to accident analysis. Also, since all the locations have high accident reputation, he has probably discussed the problem with others at the central office and possibly studied the site in the past.

The additional activity the ISHC central office traffic engineer is responsible for is that he is the team leader. He is responsible for organizing a team when the need to evaluate a high accident location arises. This member is also responsible for seeing that all pertinent information is collected and summarized for field use. He is responsible for briefing the other team members before the field investigation as to the procedure as described in the manual. He also collates and evaluates the team member's results and submits a final report to his supervisors suggesting possible countermeasures for the high accident site.

The ISHC district traffic engineer is the second member of the team. There are six ISHC districts. This member has more intimate knowledge of the high accident sites within his district. He is probably more familiar with the geometrics and traffic characteristics of the location and the accidents that have occurred there. The district traffic engineer is also knowledgeable of previous and planned maintenance at the site. He should be able to offer valuable traffic engineering input.

The local traffic engineer should be selected from the nearest city (or county) that has a traffic engineering department. This member should have first-hand experience of the problems associated with a high accident site in his area through the media, citizen complaints and personal experience. He probably drives the site frequently and may be considered an average driver for the area. His countermeasures may reflect his familiarity with the site and his engineering education and experience.

The human factors person gives emphasis to the driver's aspect. The human factors person is basically interested in the psychological, sociological and capability aspects of the driver. He possibly should be or has been involved in research of the visual aspects, judgment, perception or the influence of alcohol and drugs on the driver (10,11, 14,20,21,22). Forbes (11) edited a book which is a collection of human factors research articles as related to the driver and is an excellent reference. It is anticipated that the human factors expert will emphasize countermeasures which reflect the viewpoint of the driver in control of his own vehicle. As a member of the team he will also probably contribute to the awareness of the other members as to the importance of driver aspects of accidents. His familiarity with the locations will be a chance occurrence, so he usually will represent the unfamiliar driver.

A local law enforcement officer is the fifth member of the multi-disciplinary team. He should be obtained from a reasonably sized city (or possibly state police post) near the high accident location. He should not be a regular patrol officer but one who regularly works in the traffic division and is concerned with traffic operations and traffic

safety. This member deals with accidents, their investigations, their reports and their analysis. He is also considered a professional driver as one in his field must certainly be. He is probably very familiar with the location. His input is valuable because of his experience with accidents and dealing with drivers. Also his knowledge of traffic and motor vehicle laws is beneficial to high accident location studies.

In summary, a five person multidisciplinary team consisting of an ISHC central office traffic engineer, an ISHC district traffic engineer, a local traffic engineer, a human factors person and a local law enforcement officer is recommended to evaluate high accident locations. Additional information is presented in the job descriptions located in an appendix of the manual (Appendix A).

It is envisioned that multidisciplinary teams might be organized on a permanent basis within each ISHC district for investigation of high accident sites within that district. In this research, however, district boundaries were not strictly observed. Even though there were high accident sites in all six ISHC districts, only four teams were organized to review the eighteen high accident sites of this research study. Three of the four teams were associated with cities in the general vicinity of the accident sites; Bloomington, Indianapolis and Kokomo. The local traffic engineers and law enforcement officers were obtained from those cities. The fourth team (Independent) handled the locations that were scattered throughout the state. Various ISHC and Purdue University traffic engineering and human factors personnel were used on this team. The high accident sites studied by each team are shown in Table 2.

Table 2

High Accident Locations Assigned to Four Multidisciplinary Teams

Independent Team

1. SR 63 at SR 163 in Crawfordsville District
2. US 41 at 45th Avenue in LaPorte District
3. US 31 at Kern Road in LaPorte District
4. US 40 at Round Barn Road in Greenfield District

Kokomo Team

1. US 24 at SR 5 in Fort Wayne District
2. US 31 at SR 14 in LaPorte District
3. US 31 at SR 18 in Fort Wayne District

Bloomington Team

1. SR 37 at SR 252 in Seymour District
2. SR 67 at SR 39 (S. Jct.) in Seymour District
3. SR 37 at SR 48 in Seymour District
4. SR 37 at SR 450 in Vincennes District

Indianapolis Team

1. US 31 at SR 38 in Greenfield District
2. SR 67 at Franklin Road in Greenfield District
3. US 31 at National Avenue in Greenfield District
4. I-465 at SR 67 (NE Jct.) (2) in Greenfield District
5. I-465 at SR 67 (SW Jct.) (2) in Greenfield District

Procedural Manual

The development of the manual and the field investigation prescribed within are discussed here. The following criteria were considered important to make the manual effective. The first criterion is that the manual should be complete, simple and clear in its reference to the goals and objectives of the team. Secondly, the manual should outline the function of the team, what data needs to be provided and what is required of team members. Thirdly, the manual should outline concisely the field procedure that is to be followed by the team members as well as the team leader. Lastly, and most importantly, the manual and its prescribed procedure must be flexible so as to be applicable for any high accident location to be selected for study by a multidisciplinary team.

The manual shown in Appendix A is not exactly the one used in the field investigations of the eighteen ISHC designated intersections for this research but is a revised draft based on experience from the research. The procedural manual is also a modified revision of material contained in references 9 and 27.

It was decided that the manual should define the goals and objectives of the study in a very simple, clear manner. Following this, the organization of the team is discussed with reference to the individual member's job description contained in the Appendix AA of the manual. The field equipment as a minimum requires an automobile and a notebook. Optional equipment is described such as a tape recorder which might be helpful in the field. The field data requirements are a condition diagram, collision diagrams, accident summary tables and traffic volumes.

The next portion of the manual is a description of the field investigation procedure of the high accident locations. The procedure is organized into twenty-six steps with the first eighteen required for the team members in their investigation and the rest for the team leader to follow in his evaluation of the data. The field procedure used by the teams in this research is basically as shown in Appendix A. A few of the steps have been rearranged from what was originally used but the procedure is generally the same.

A briefing session of the members as to the procedure they are to follow is the first step. At this meeting a date for the return of the materials is determined. The members then visit the site individually.

The members at the site personally drive all the approaches to the site recording manually and/or on a tape recorder any comments or observations. A review of the condition diagram, collision diagrams, accident summary tables and volume diagram and general observation of the site follows. The members then make their determination of the predominant accident types, causal factors and possible countermeasures. They submit a report of their findings. A team meeting is called by the team leader to discuss the investigated site and to form a consensus opinion as to the predominant accident type, causal factors and possible countermeasures.

The last nine steps cover the evaluation process the team leader must follow. This process involves interpreting the several members' evaluation forms and summarizing their results to determine if a consensus is formed as to the accident type, possible causes and countermeasures. A meeting of the team is called where the high accident site

is discussed and a team consensus is hopefully reached. A report is prepared and submitted to the Chief, Division of Traffic Engineering, ISHC, with or without recommendations.

Using a step-wise procedure, it is believed that a simple and easy-to-follow process has been established. All criteria established for the development of the manual were met. It is believed that the manual is flexible enough to be used for any high accident location and not just for highway intersections.

Field Data

The literature review indicated that for an effective accident analysis certain field data such as condition diagrams, collision diagrams, accident summary tables and volume data must be obtained. It was discovered that this data could indeed be obtained and put in usable form. This material was then used in the field investigations. Additional data, such as from conflict and speed studies could be included, but this information is usually not readily available. Consequently, this material is not part of the data recommended.

The condition, collision and volume diagrams as well as the accident summary tables are sufficient for an effective on-site evaluation of the high accident locations. Copies of these data are required for each member at each location. Each type of data will be explained further showing how it evolves from the raw data to the finished field data. The data packages supplied the individual team members for each location of this research are for five of the locations on which the study is contained in an Appendix of this report.

Condition Diagram: The condition diagram is a scale drawing of the high accident location. The diagram shows skew, horizontal curvature, the roadway geometrics, signs, traffic control devices and their relative position within the intersection. The purpose of the condition diagram is to give the team member a concise planimetric view of the intersection layout before visiting the site. An 8-1/2 by 11 inch reduction of the diagram accompanies the full size diagram for ease in handling and for quick reference.

For the locations of this research project, some data for the condition diagram were acquired by field survey. The field measurements were taken with a distance wheel. Since the scale of the condition diagrams was small, the accuracy provided by a distance wheel was adequate. Skew and degree of curvature were obtained from records of the ISHC. An example of a condition diagram in the 8-1/2 x 11-inch format is shown in Figure 2.

Collision Diagram: The collision diagrams, one for each year with a minimum of three years of record, are made available to the team members. The years used in the locations of this research were 1974, 1975, and 1976. Each diagram shows what type of accident occurred, the general direction of travel of the vehicles involved, the severity of the accident, the type of vehicles involved, the date, the pavement condition and the time of day. There are two possible ways of obtaining this information. One method is by obtaining the individual accident reports with the cooperation of the Indiana State Police. The other method is to obtain the accident reports in summary form from the ISHC. The Traffic Division provided the information for this investigation. The

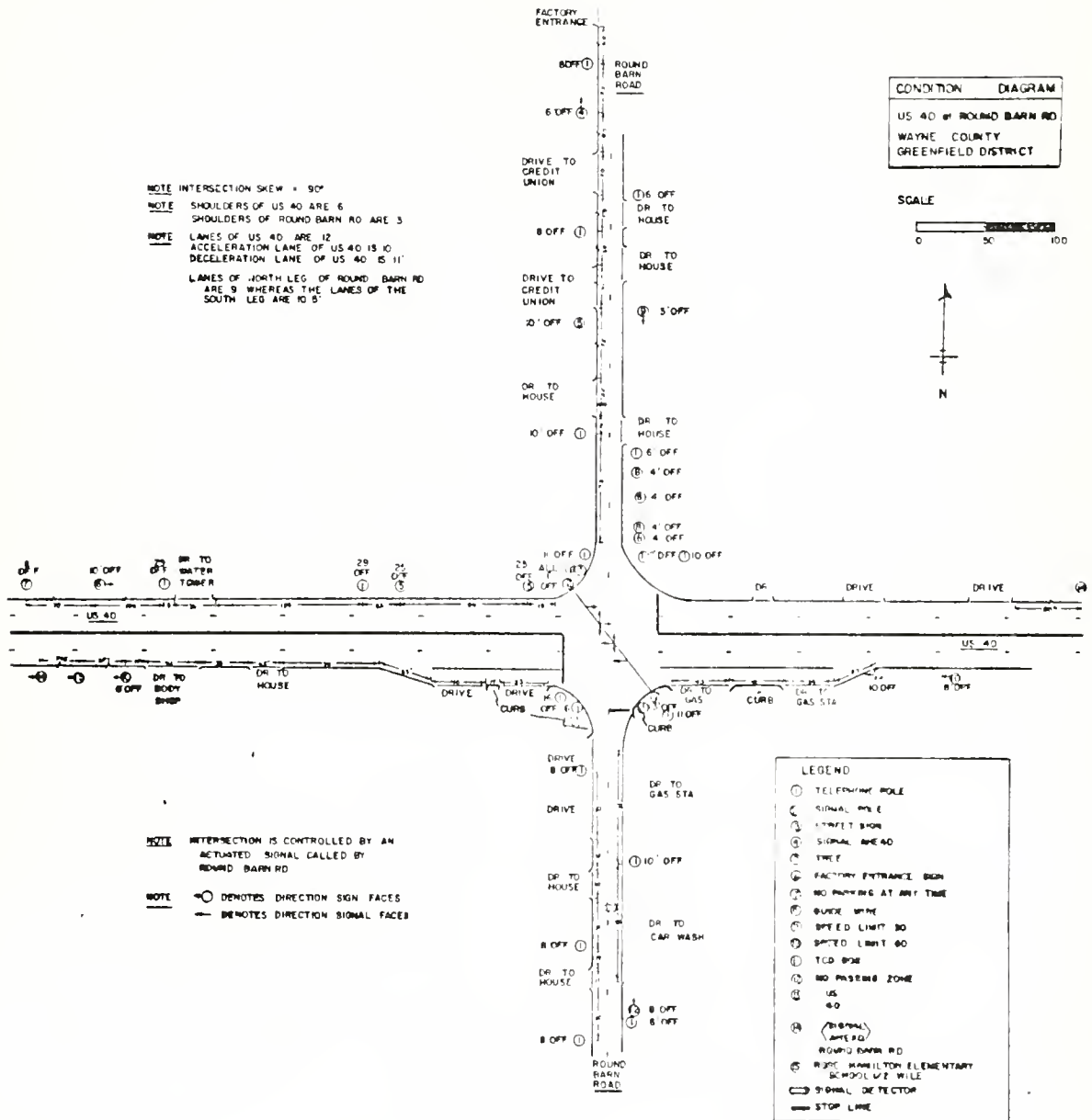


Figure 2. Condition Diagram for US 40 at Round Barn Rd. (Example)

purpose of the collision diagrams is to aid the team members in determining the predominant accident types as well as indicating some possible causal factors. Trends in accidents might possibly be discovered over the three years of record by examining this data. An example of a collision diagram is shown in Figure 3. A minimum of three years of collision diagrams should be provided.

Accident Summary Table: The accident summary table, one for each of three years, are for the same years as the collision diagrams, which in this case were 1974, 1975, and 1976. This form is the same as used by the ISHC. The accidents for each year are summarized by light condition (day or dark), severity of accident as number of injured or killed, type of accident, pavement condition, day of the accident and time of day. This information is extracted from the individual accident reports or the accident reports in summary form supplied by the Indiana State Police to the ISHC Traffic Division. These tables may possibly point to trends in accident types over the three years or show particular problem times or conditions. An example of an accident summary table is shown in Table 3.

Volume Diagram: The purpose of the volume diagram is to show exactly how many trucks and autos make turning or through movements at each high accident location. The volumes of each maneuver for each approach by auto or truck should be in average daily traffic (ADT). The entering volumes in terms of ADT for the major and minor routes of the locations in this research for 1974, 1975 and 1976 were obtained from the Planning Division of the ISHC. A projected 1977 ADT was calculated using the average percentage increase over the three years. The

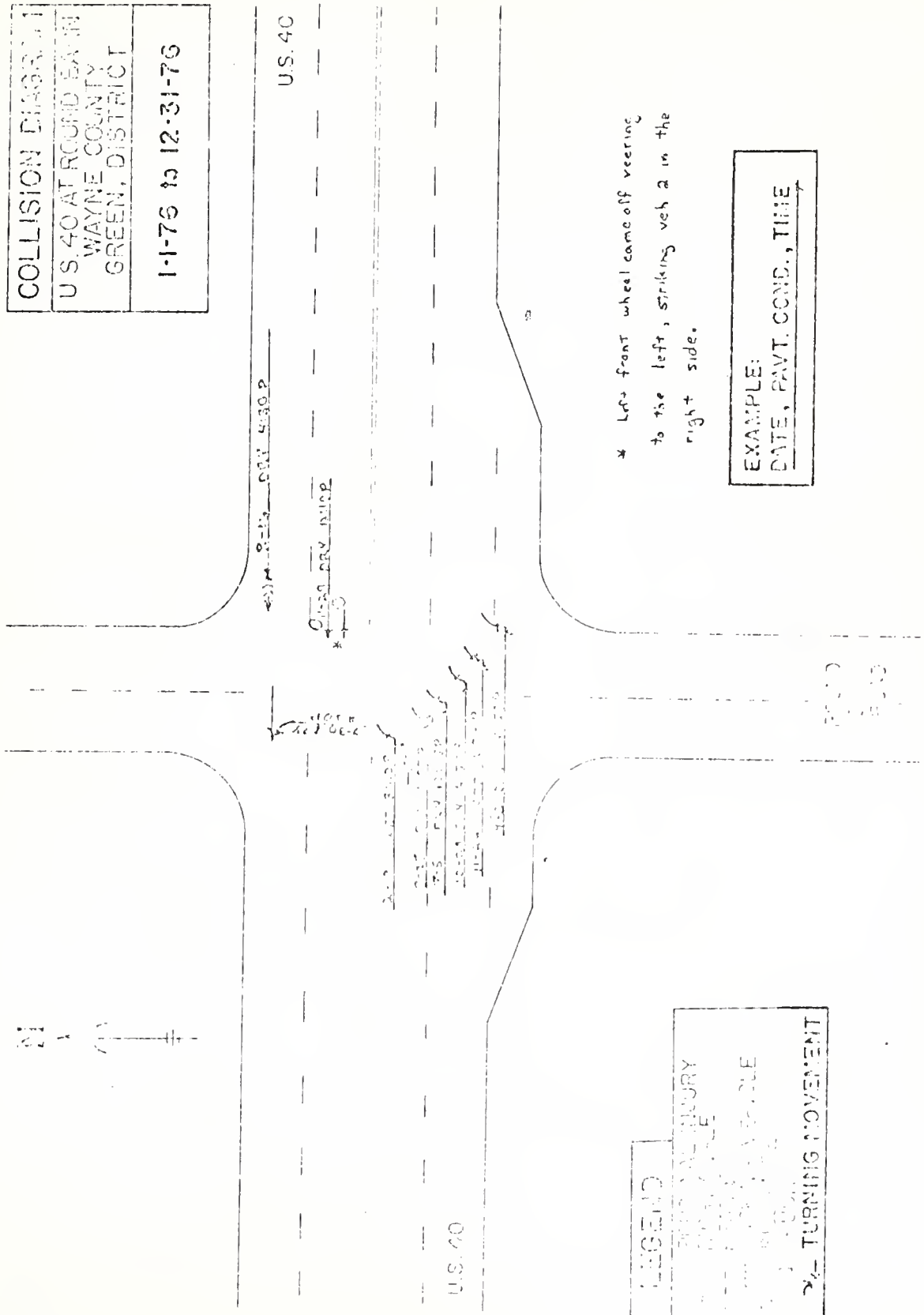


Figure 3. Collision Diagram for US 40 at Round Barn Rd. for 1976 (Example)

Table 3. Accident Summary Table for US 40 at Round Barn Rd. for 1976
(Example)

ACCIDENT

SUMMARY

LOCATION: US 40 at Round Barn Rd.

Wayne County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL
ACCIDENTS

9

DAY

8

DARK

1

PERSONAL
INJURY

1

PROPERTY
DAMAGE

8

FATAL

INJURED

1

KILLED

REAR END

1

RIGHT ANGLE

OUT OF
CONTROL

TURNING
MOVEMENT

L= 7 R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

1

ROAD CONDITION

DRY

WET

SNOW/ICE

OTHER

7

2

SUN.

MON.

TUES.

WED.

THUR.

FRI.

SAT.

3

1

1

4

TIME FACTOR

12-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 TOTAL

AM

PM

1

3

1

1

2

1

9

average percentage increase was found to be between two and four percent depending on the location under study. Applying this average percentage increase to the 1976 ADT, a projected 1977 ADT was obtained.

The individual turning maneuvers in terms of autos and trucks were not available from existing records. Two one-hour traffic counts were conducted at the individual sites to determine this information. These two one-hour counts were averaged. The volume for each maneuver was then figured as a percentage of the total average volume during the two hours for each road. This percentage was then applied to the projected ADT. This procedure was used for each high accident location. An example of a provided volume diagram is shown in Figure 4.

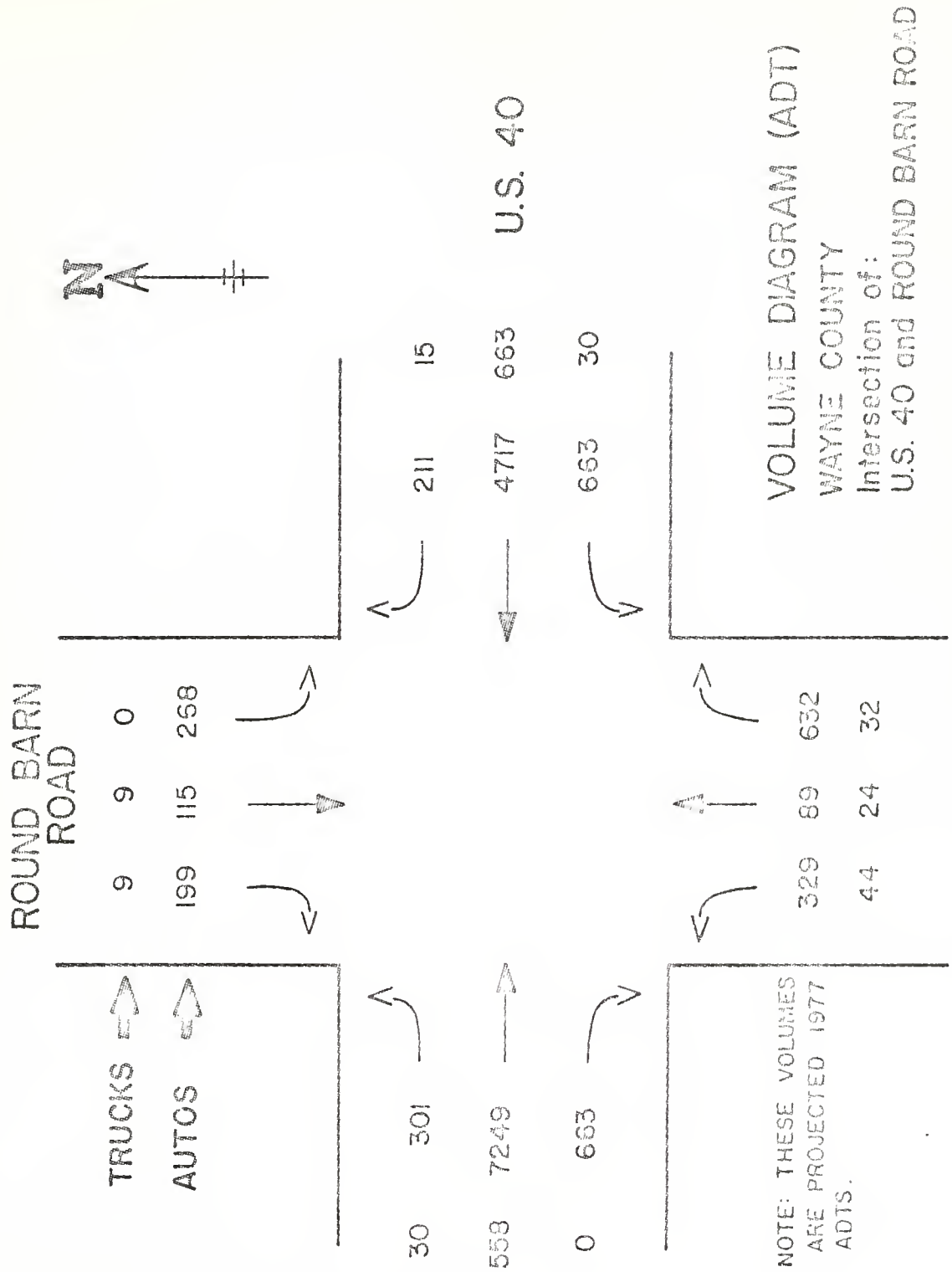


Figure 4. Volume Diagram for US 40 at Round Barn Rd. (Example)

CHAPTER IV: RESULTS OF THE TEAM INVESTIGATIONS

This chapter is divided into two portions. The first section addresses the development of the evaluation procedure and reports the team evaluations for the five high accident locations on which team meetings had been held as of July 1978. For expediency, only the predominant accident type, its primary causal factor and the recommended countermeasures are discussed in this chapter. The complete results for the five sites are presented in Appendices B through F. Each Appendix includes a brief discription of a high accident location, several photographs of the location and the team evaluation results.

Although the five high accident sites at which team evaluations have been completed are reviewed in this report, the review is for the purpose of providing documentation for the validity of the multi-disciplinary team evaluation of high accident locations. As these sites were classified as high accident locations in the Indiana highway system, additional benefits from this research will result from recommendations which now can be made as to improve these sites. Furthermore, similar recommendations should result from the team investigations at the other thirteen sites following the meetings of these teams to be held subsequent to July 1978. These additional team results and recommendations relative to the countermeasures developed by the teams will be provided in a subsequent report following the completion of the simulation of

these recommended countermeasures which is being developed as the third phase of this research.

The second section of this chapter deals with the results of the team members' responses to a questionnaire (Figure 5) dealing with the sufficiency of the field data, the adequacy of the stepwise procedure and the clarity of the manual.

Evaluation Procedure

The evaluation procedure of the team members' results of the high accident intersections basically evolved from a number of trial procedures that are discussed below.

When the team members' results were received, they were interpreted and translated into brief, concise wording. The results for each site were next tabulated on two different sets of forms. The first set of forms as shown in Figure 6 tabulated the suggested countermeasures by causal factor and by accident type. On this form, CTE is the ISHC central office traffic engineer, DTE is the ISHC district traffic engineer, LTE is the local traffic engineer, LEO is the local law enforcement officer and HFM is the human factors man. Each member's ranking of that particular element was given.

This form was developed in hopes that a majority of members on a team would suggest similar causal factors and countermeasures for a particular accident type. If this were true, team meetings to discuss the high accident sites would be optional. After evaluating the team results in this manner, it was obvious that few members of a team agreed on the causal factors. It should be noted that accident types in order of importance were usually easily identified by all members. A large

EVALUATION OF THE MANUAL AND ITS PROCEDURE

IS THE FIELD DATA FOR EACH LOCATION SUFFICIENT FOR THE
MEMBERS' NEEDS? IF NOT, WHAT ADDITIONAL INFORMATION
SHOULD BE PROVIDED? _____

DOES THE STEP BY STEP PROCEDURE SEEM ADEQUATE? IF NOT, WHAT
ADDITIONAL STEPS WOULD LIKE TO SEE INCORPORATED OR
PRESENT STEPS MODIFIED OR ELIMINATED? _____

Figure 5. Questionnaire on the Manual and Its Procedure

DOES THE MANUAL CLEARLY EXPRESS THE PROCEDURE TO BE USED
BY THE TEAM? WHERE AND IN WHAT WAY COULD IT BE
IMPROVED? _____

ADDITIONAL COMMENTS AND OBSERVATIONS: _____

Figure 5. (Continued)

LOCATION EVALUATION

Location:

	<u>CTE</u>	<u>DTE</u>	Rank <u>LTE</u>	<u>LEO</u>	<u>HFM</u>	Degree of <u>Agreement</u>
Accident Type: _____	_____	_____	_____	_____	_____	_____
Cause: _____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____

Figure 6. Tabulation Form for the Evaluation of a High Accident Site by Accident Type, Causal Factor and Countermeasures

amount of diversity was present, however, in the recognition and identification of the causal factors. The countermeasures, therefore, did not appear to relate to and group with causal factors. The causal factors were somewhat related yet often quite different. As an example team members suggested speed, poor signal visibility and inadequate sight distance as possible causes for a certain accident type.

Upon examining the team evaluations, it was clear that certain countermeasures were the consensus but were suggested under different causal factors. Another evaluation form, such as shown in Figure 7, was hence developed which evaluated the sites and disregarded causal factors. The abbreviations used on this form are the same as those on the previous form. This summary form did group countermeasures suggested by accident type.

As agreement was generally not achieved with the evaluation forms, it was decided to have two of the teams meet to determine if discussion between members would evolve into a group consensus of predominant accident types, possible causal factors and suggested countermeasures. The Independent team and the Indianapolis teams were selected for this task.

The Independent team discussed two high accident intersections which were SR 63 at SR 163 and US 41 at 45th Avenue.

Relative to the SR 63 at SR 163 intersection, team discussion determined that right angle accidents were the most detrimental and members felt that poor visibility of the flashers on SR 63 was the major cause. The countermeasures suggested to minimize this cause were to increase the wattage of the lamps, place the flashers along the lane lines instead of in the center of the lanes (to minimize obstruction of

LOCATION EVALUATION

Location: _____

Accident Type: _____	CTE	DTE	Rank LTE	LEO	HFN	Degree of Agreement
Countermeasure: _____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
Countermeasure: _____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

Figure 7. Tabulation Form for the Evaluation of a High Accident Site by
Accident Type and Countermeasures

visibility by trucks), and install a third flasher for each direction on SR 63. Further results of the team discussion are reported in Appendix B.

The Independent team decided that rearend accidents were the predominant type at the intersection of US 41 at 45th Avenue. The prime cause suggested was poor signal visibility. The countermeasure recommended to alleviate this accident type and this causal factor was to arrange the signals in a box configuration instead of stringing them diagonally across the intersection. The remaining results of this team discussion for US 41 at 45th Avenue can be found in Appendix C.

The Indianapolis team also met to discuss three high accident sites which they had studied. The three intersections chosen were US 31 at SR 38, SR 67 at Franklin Road and US 31 at National Avenue.

The Indianapolis team determined that at the US 31 and SR 38 intersection right angle accidents were the predominant type and were caused mainly by poor visibility of the intersection. The team suggested seven countermeasures which might alleviate this situation. It must be noted that this location is currently operating with a traffic signal which only is used for flashing operation - red to SR 38 and amber to US 31. The countermeasures suggested were to reduce the grade on US 31, activate the signal from 7:00 AM to 7:00 PM, increase the advance warning distance and install flashers on these signs, enlarge the lens size on the flashing signals at the intersection, add a strobe to the flashing signal lights, double the flashing signal heads by placing one on top of the other, and install the advance warning sign with a flasher that is activated when the activated signal is operating and is

discussion are reported in Appendix D.

For SR 67 at Franklin Road, it was suggested by the team that left turning movement accident was the predominant type and that the high volume of traffic was the main cause. No countermeasure was suggested by the team to alleviate this cause. Other causal factors were also pointed out and countermeasures for these factors were suggested by the team. These and additional results are shown in Appendix E for SR 67 at Franklin Road.

The third intersection discussed by the Indianapolis team was US 31 at National Avenue. It was decided that drivers on US 31 were accepting insufficient gaps causing left-turning movement accidents. The countermeasures suggested to relieve this situation were to supplement the pavement markings on US 31 with an overhead sign with arrows designating lane usage, construct left turn bays on US 31, add a left turn signal phase and eliminate National Avenue access, though this was felt unlikely to be implemented. Other results are discussed in Appendix F.

The team meeting was found to be helpful in obtaining a team consensus since the researcher has limited traffic engineering experience. In this study for the team meeting, each member was supplied with the two sets of evaluation forms before the meeting started. These forms with the free flow of ideas allowed the team members to readily reach a consensus as to the predominant accident types, causal factors and possible countermeasures for each site investigated. At these meetings, often one member would point out a characteristic of the site the others had not realized. Then discussion of this characteristic would follow. Since the meetings yielded satisfactory results, a team meeting was made an optional step in the field procedure if the team leader felt that a group consensus through tabulation was not possible. Utilizing the step by step

procedure with an experienced traffic engineer as the team leader, it is believed that with his interpretation of the individual member's evaluations of a site, a team consensus through tabulation is more probable and consequently a team meeting may be unnecessary.

It is planned that the teams will meet to discuss those remaining sites for which an experienced traffic engineer acting as team leader can not form a group consensus through tabulation. For those sites that require the team meeting, the members will try to form a team consensus as to the accident types, causal factors and countermeasures for alleviation of the high accident problem.

Questionnaire Results

Sufficiency of the Field Data: The members responding to the first question of the questionnaire, "Is the field data for each location sufficient for the members' needs? If not, what additional information should be provided?" offered many good suggestions as to supplemental or additional field data that would be of value. Each suggestion is referred to below and then is responded to in regard to its inclusion in the field data.

1. One member suggested that a map with the geographical location of the site be included. In this study, a state map with the site identified was given to each member. A larger scale county or city map would be appropriate. This suggestion was written into the manual as part of Step 1.

2. Three members suggested that any changes made at the site during the three years of accident data be documented as to what was done and the date it was made. This information would be of great help to the team members and definitely merited inclusion in the manual. This data should be noted in a block on the condition diagram.

3. Two members recommended including the signal phasing and timing of the signalized intersections on the condition diagram. This data is easily attainable for fixed time signals and should be provided on the condition diagram. The timing of activated signals, of course, cannot be supplied though the phase capabilities should be shown on the condition diagram.

4. One member suggested showing the intended paths of the vehicles on the collision diagram. This was intended on the diagrams supplied but it must not have been obvious. The drafting at the accidents on the collision diagram should clearly show the intended paths of the vehicles.

5. A member commented that showing which driver disregarded a signal on the collision diagram would be beneficial. This is possible to show with the information of date, pavement condition and time of day on the arrow of the vehicle which had the right-of-way. Inclusion of this information was added to the manual.

6. One member suggested showing the driver arrest records on the collision diagrams. This is not included in the manual because of space limitations of the collision diagrams and the difficulty of obtaining this data.

7. One member suggested mentioning on the collision diagram if any visual obstructions were present at the time of the accident. This information would be of great benefit but unfortunately is not usually noted on accident reports. Consequently, this is not included in the manual.

8. One member thought the ages of the drivers involved should be noted on the collision diagrams. This data is available from the

accident report but is felt to be of limited value in development of design and operational countermeasures and was not added to the manual.

9. One member suggested that the comments of the officer at an accident be made available and two other members felt that the individual accident reports would be beneficial to the members. These suggestions were not included in the manual for two reasons. The first reason is that the data would be too bulky, somewhat overwhelming and too difficult to handle. Secondly, problems of the legality of releasing this information to so many people would arise.

10. Two members mentioned that the latest years available should be the accident data provided. This, of course, should be done. However, it takes time for the state police to receive all the accident reports and tabulate them. The most recent year of data may not always be available.

11. One member suggested that all three years of accidents be reported in one accident summary table. This merited inclusion into the manual since it would give an overview of the accident problem at the high accident site.

12. One member suggested that state statistics of percentages for types of accidents occurring, number of snow days, etc. to use as comparison to the location under study would be helpful. This data is not readily available, and hence was not included in the manual.

13. One member suggested developing a confidence interval by number of accidents that would show what variability over the years can be explained by the randomness of accidents. This would be beneficial but is normally not done, hence providing such data was not added to the manual.

14. One member recommended including hourly traffic counts in the field data. Peak hour counts should always be included but hourly counts would be of limited value and are not suggested in the manual.

Many of the additions suggested relative to the condition diagram were implemented whereas only a few of the suggested modifications to the collision diagram were found to be practical of inclusion.

Adequacy of the Manual: The members were asked to respond to the following question, "Does the step by step procedure seem adequate? If not, what additional steps would you like to see incorporated or present steps modified or eliminated?" Any suggestions meriting inclusion were included in the finished manual in Appendix A.

1. One member suggested that before reviewing the field data that the drive through the site be completed instead of vice versa as originally specified. This has merit since it would make the member's awareness of geometric and traffic features similar to that of a typical driver. It was made a part of the manual.

2. Two members felt that more emphasis be applied in the manual relative to driving the location approaches more than one time. This emphasis has been strengthened in the manual.

3. Three members recommended that the location be analyzed at various times of the day such as at peak hour or at night. It is recommended in the manual that the location be driven at least once during the day and once during the peak hour. The members of the team are also encouraged to drive the various legs of the site under various traffic and environmental conditions.

4. One member suggested that as a part of the field evaluation, all the turning movements be driven. To minimize time in the field, this

was not included in the manual. The benefit derived from this is minimal and the repetition of driving the same approach dulls the member's power of observation. Any turning movement involved in a significant accident type should, of course, be driven.

5. Listing of all possible countermeasures for all accident types was recommended by one member. This was first examined when developing the procedure but it was felt that this would not allow innovative or new ideas for countermeasures to be introduced. This is still believed to be true. Consequently, this suggestion was not introduced into the procedure.

6. One member recommended sending a summary of the team results to each member involved. This informs the members of the final results of their team investigation and will further generate goodwill between the agencies involved in the study. This is a reasonable suggestion and is included in the procedure.

Most of the modifications to the step by step procedure, as listed above, were included in the manual.

Clarity of the Manual: In response to the third question concerning the clarity of the manual, all thought it was sufficient except one member. He recommended that on the field evaluation form for the individual site a list of features to look for, such as, sight distance, possible obstructions, and traffic control devices be included. This automatically focuses the member's attention to those features possibly obscuring other more important features. For this reason, this was not recommended.

A few members responded under the general comments and observations section of the questionnaire. One member felt additional space on the

the field evaluation forms was needed. This can easily be done. Another member suggested putting the member's name, location and date on all forms. This also can easily be done. A third member suggested substituting one of the disciplines with that of a typical driver. This would allow a lay person's input to be included in the study. Use of such an average driver as a team member is being suggested as further research.

CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Based on the experience from developing and testing a multidisciplinary team approach to the investigation of high accident locations, the following conclusions are offered:

1. A multidisciplinary team for reviewing and analyzing high accident locations is beneficial to developing countermeasures. Teams composed of five persons with professional interests in traffic safety, including one human factors specialist, performed effectively in this research.
2. Field data supplied to each team member -- consisting of a condition diagram, three years of collision diagrams and accident summary tables and traffic volume diagram -- were adequate for the accident site investigations.
3. The field procedure outlined in the manual was found to be effective in both leading the team members through the field study of a high accident location and in forming a team consensus as to predominant accident type, causal factors and possible countermeasures.
4. Individual team member's evaluation of causal factors was found to be quite variable but the collective team effort at a team meeting was very effective in developing a consensus of actual countermeasures.
5. Individual team members often must drive each approach of an accident site under varying operational conditions to effectively

identify the causal factors of accidents at that location.

6. A multidisciplinary team approach to evaluating high accident locations appears to be valuable in the accident analysis process and should be utilized in developing countermeasures.

This study by developing a multidisciplinary team approach that assists in alleviating high accident sites accomplished all prescribed tasks; yet the following recommendations for further research were found to be of merit:

1. Perform a before and after study of the high accident locations after two or more years to determine if any countermeasures suggested by the team and implemented by the ISHC did indeed alleviate the high accident problem.

2. Contrast and compare the team recommended by this research to a team organized to include a lay person and an ISHC district maintenance person.

3. Test the multidisciplinary team approach on other high accident locations (non-intersection locations, urban locations, county road locations, etc.)

ANNOTATED BIBLIOGRAPHY

ANNOTATED BIBLIOGRAPHY

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APPENDICES

APPENDIX A

MANUAL FOR MULTIDISCIPLINARY TEAM STUDY OF
HIGH ACCIDENT LOCATIONS FOR THE INDIANA STATE HIGHWAY COMMISSION

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Developed as
Part of the Research Entitled
Evaluation of Design and Control Alternatives to Improve
Safety of Intersections of Multi-Lane Rural Highways

by
Joint Highway Research Project

This research was performed in cooperation
with the Indiana State Highway Commission
and the Federal Highway Administration,
Department of Transportation.

Purdue University
West Lafayette, Indiana

August, 1978

APPENDIX A: MANUAL FOR MULTIDISCIPLINARY TEAM STUDY OF HIGH ACCIDENT LOCATIONS FOR THE INDIANA STATE HIGHWAY COMMISSION

Purpose

It is the purpose of this manual to serve as a guide for the field investigation of highway locations with high accident incidences using a multidisciplinary team approach. The manual provides guidelines for a team and its members to follow to identify the predominant accident types, the major causal factors and possible countermeasures for high accident experience locations. The manual is applicable to all locations, intersections and other roadway sites and sections.

Objectives

The objective of the manual is to outline a technique to be used for the evaluation of high accident locations. The multidisciplinary team approach to be used provides for input from law enforcement officers and human factors experts in addition to traffic engineers. The members of the team must be knowledgeable of and be concerned with drivers and highways. The varied combinations of training and experience incorporates different perspectives of the problem and thus allows a more complete and comprehensive consideration of possible solution alternatives at problem locations.

The multidisciplinary team approach outlined herein provides for the perspectives of persons expert in the areas of human factors and law

enforcement as well as in traffic engineering. In this way, the driver's aspect is perhaps better taken into account. With the problem viewed from these various perspectives, an encompassing and comprehensive solution should be better realized.

The final product of the team analysis is a suggested countermeasure(s) to alleviate the high accident location. This suggested countermeasure(s) is then available to the decision makers to determine the final course of action.

Organization

The multidisciplinary team will consist of five people. The team will include a local law enforcement officer, a human factors person, an Indiana State Highway Commission (ISHC) central office traffic engineer, an ISHC district traffic engineer and a local traffic engineer. The job descriptions for each of the above are outlined in Appendix AA. Team members should be chosen on the basis of qualifications as prescribed. It, however, may not always be possible for all members to meet all the required qualifications and good judgment will then need to be exercised to obtain a competent team.

An ISHC central office traffic engineer will be the team leader and provide the necessary direction for team organization and utilization. A central office traffic engineer was selected as he is best able to coordinate the team and its activities for ISHC problem sites. He will have access to the traffic data and accident records required to guide the work of the team. Collision, condition and volume data for each site to be investigated will be prepared by the central office and distributed by the team leader. The team leader will also be responsible

for reporting the findings of the team to the Chief, Division of Traffic Engineering, ISHC.

Field Equipment

The equipment and materials needed by each member of the multi-disciplinary team will be as follows:

1. a vehicle
2. a notebook
3. a portable cassette tape recorder with pick up (optional)
4. one two-hour cassette tape (optional)
5. a camera (optional).

These materials will be required at each location studied. The team leader should ascertain that each member has the necessary equipment and supplies in advance of visiting the locations.

Data Requirements

Prior to visiting each of the locations for which he is responsible, a team member will be provided the following for the location:

1. condition diagram
2. collision diagram
3. accident summary table
4. traffic volumes for the roadways involved.

Each team member should review these data in detail before driving to the location, should take them to the site when it is visited, and will undoubtedly find the data of most value while observing the site.

Condition Diagram

The condition diagram will contain details of the physical conditions of the roadways involved. All diagrams will be clearly identified

with the highway location, the county, the ISHC district and a north arrow. The diagram will include the number of lanes, lane widths, shoulder widths, possible sight obstructions, all traffic devices, signs and their approximate placement with respect to the roadway and channelization islands. The diagram will by note include any changes in the geometric or signing characteristics made at the location during the period for which accident data were provided as well as the date they were made. The phasing and timing of a signal, if present, will also be included. The condition diagram should give a complete perspective of the high accident location. The information for the condition diagram is procured from official plans and by field inspection. For ease in handling, a reduction of the condition diagram to 8-1/2 by 11 inch size will accompany the full size condition diagram. An example of the reduction of the condition diagram is shown in Figure A-1.

Collision Diagram

The collision diagrams will show accident data, preferably for a one year period, for each site. At least three such annual diagrams should be available. The diagram of any one year will contain such accident information as time of day, date, type of accident, pavement condition, types of vehicles involved, and the intended path of the vehicles. For any single accident, any driver involved in a moving violation is indicated. This information can be obtained from accident reports maintained by the State Police and the ISHC Traffic Division. An example of a collision diagram is shown in Figure A-2.

Accident Summary Table

The accident summary table will include an overview of the accident history of the location. It will show annual figures for types of accidents, severity of accidents, the number of personal injury accidents, the number of fatal accidents, time of day, day of week and light condition. The summation of all three years of accident data will also be shown in a similar table. This information is obtained from the individual accident reports. An example of an accident summary table is shown in Table A-1.

Traffic Volume Data

The traffic volumes of the roadway(s) involved will be supplied to the team. The volumes should be Average Daily Traffic (ADT). The data that is most useful is the individual daily vehicle movements at the site. To obtain an estimate of these volumes a short count may be performed or the counts may be available from ISHC or other records. When the volumes are secured, they may be illustrated in a volume diagram as shown in Figure A-3. A diagram showing the peak hour counts is also to be supplied to the members.

As mentioned before, all the data will be gathered, condensed and distributed by the team leader. The data will be distributed in a folder to each team member and the folder will be identified with the site location, county, ISHC district and the latest date a report on the intersection is due to the team leader.

Procedure

The specific field procedure to be followed by each team member is given in the following 18 steps:

Step 1

Team members obtain instructions and pertinent data from the team leader at a team meeting. The team leader will establish the time and place and give the appropriate directions to the meeting place. The meeting place should be convenient to all members of the team, perhaps in the office of the traffic engineer closest to the location. Several teams may meet together for their initial meeting. For example, all members of all teams concerned with all locations in an ISHC district might meet at a single initial meeting.

At this meeting, a tentative schedule of when the members should observe the locations should be established. The locations will be visited independently by each member of that location's team. A final due date for team members to report the results of their field observations and analysis should be given by the leader. This date should allow each member enough time to visit the sites at his convenience but must be within a limited time span. The team leader will distribute the site folders and review the prescribed field inspection procedure. The team leader will distribute large scale (county or city) maps showing the exact location of the sites. The team leader will answer any questions the members might have.

Step 2

The members will individually visit the high accident locations assigned to them during the allotted time. It cannot be stressed enough that the members are to investigate the sites individually. If two team members should meet during the observation period, they should not discuss the location or their opinions of the location until

both have submitted their reports. There must be as little interaction between team members as possible during the field studies so that bias is minimized. It is important that the observations of each individual be recorded and not exposed to other opinions.

The site should be visited on a dry day during the peak hour period. If the member feels that the collision diagram and accident summary table indicate that a certain day, time or condition may be an important factor, the location should be visited during that time as well.

Step 3

Once at the location, the team member should pull off the roadway at a safe place but within view of the site. At most of the locations, a gas station or restaurant parking lot can be utilized. Otherwise, the shoulders are often wide and safe if the auto's emergency flashers are used.

Step 4

The driver should record the time, day, date and weather conditions such as winds and light conditions.

Step 5

Each direction of roadway or leg of intersection should then be driven from at least a quarter mile away from the high accident location. The direction of traffic movement on the leg should be recorded on the form provided before it is driven. Observations or comments pertaining to the leg or section should be recorded also. Some things to look for are sight distances, signs, markings, obstructions, and traffic

control devices. The member should observe the high accident location as it would be seen through the eyes of a typical driver. If the member feels that a picture of a certain aspect of the location would help clarify a point he wishes to make, he should feel free to do so.

Step 6

If it is felt by the driver that it would be beneficial to redrive a section, leg or possibly the whole intersection, he should feel free to do so. If the member decides to do so, he should remember to record all necessary traffic movement directions as well as any additional comments.

Step 7

The member, after driving all the legs of the intersection, should once again pull off the road but within visual range of the location.

Step 8

The member should review the data supplied to become thoroughly familiar with the location. If anything on the condition diagram is not proper or is missing, the information should be added as required in the proper position.

Step 9

The member should try to visualize how the location functions with its given volume (ADT) and record any comments. The member may also desire to drive the location during the peak hour (or any other problem period) and it may be beneficial to do so.

Step 10

The member should try to visualize the accidents which have occurred and are shown on the collision diagram as if he were an average driver. Also the member should review the accident summary tables.

Step 11

If the member perceives potential hazards, near-accidents or safety violations, these should be recorded.

Step 12

The team member should transfer the information as recorded to the form which is shown in Figure A-4.

Step 13

The team member should determine the predominant and other accident types which occurred at the high accident location. For each accident type a form, as shown in Figure A-5, should be filled out.

Step 14

Based on the data provided and the member's observation and judgment, the member should select those causal factors which he believes to exist for each accident type. The causal factors should be listed in the order of their importance, the most important listed first.

Step 15

A similar procedure should be used for possible countermeasures. The member should list the countermeasures which in his opinion would be helpful for accident reduction at this site, for a specific cause,

again in order of decreasing importance. The member should list any countermeasures that could improve the location.

Step 16

The member should review the checklist to be sure no part of the field procedure has been forgotten. The checklist is shown in Figure A-6. If something has been forgotten, the member should do it.

Step 17

The member can then proceed to the next location or return home.

Step 18

The member should then send all forms to the team leader as quickly as possible.

Steps 19 and following are to be performed by the Team Leader:

Step 19

It is the team leader's responsibility to assemble all of the field studies into a group consensus. He should give equal weight to each of the studies in making such a summary. The leader in this task is to be simply a compiler of the individual member's results. If the team leader has a personal bias that does not permit such unbiased summarization, then another qualified person from the ISHC Central Office should be assigned this task.

Step 20

The team leader should check on team member's agreement on the primary and other accident types. In this area, there should be little

disagreement. The tabulation sheets shown in Figure A-7 and Figure A-8 should be of assistance to the team leader.

Step 21

Interpretation of each member's observations and suggestions should be the next step. They should be recorded into similar language on all reports so they can be more easily summarized. For instance, one member might write that the signal is not visible while the driver should be slowing down; an interpretation would be sight distance of signal inadequate on approach A. Any interpretations should be written in another color next to the statement on the member's form. If the leader does not understand a statement or comment, the team member should be contacted for clarification.

Step 22

The causal factors should then be tabulated.

Step 23

The countermeasures should be tabulated on both forms.

Step 24

Examination of the tabulation forms may show a consensus as to the types of accidents, possible causes of the accidents, and possible countermeasures.

Step 25

The team leader may organize a team meeting if team consensus was not reached by tabulating the members' results. At the meeting, each member should be returned his evaluation forms, given a copy of the field data package if needed, and given a copy of the two sets of

tabulation forms of the team results. Discussion should illuminate why the individual members reported the way they did. General, organized and constructive discussion after all members have explained their opinions, will hopefully lead to a consensus opinion. During this meeting, the team leader must maintain control and not allow the discussion and eventual consensus to be dominated by one member.

Step 26

If this meeting does or does not produce a group consensus, the team leader should write a summary report of the results as best he interprets the findings of the members and present it to the Chief, Division of Traffic Engineering, ISHC. Such a summary even of a team in disagreement will add input to the process of correcting high accident locations.

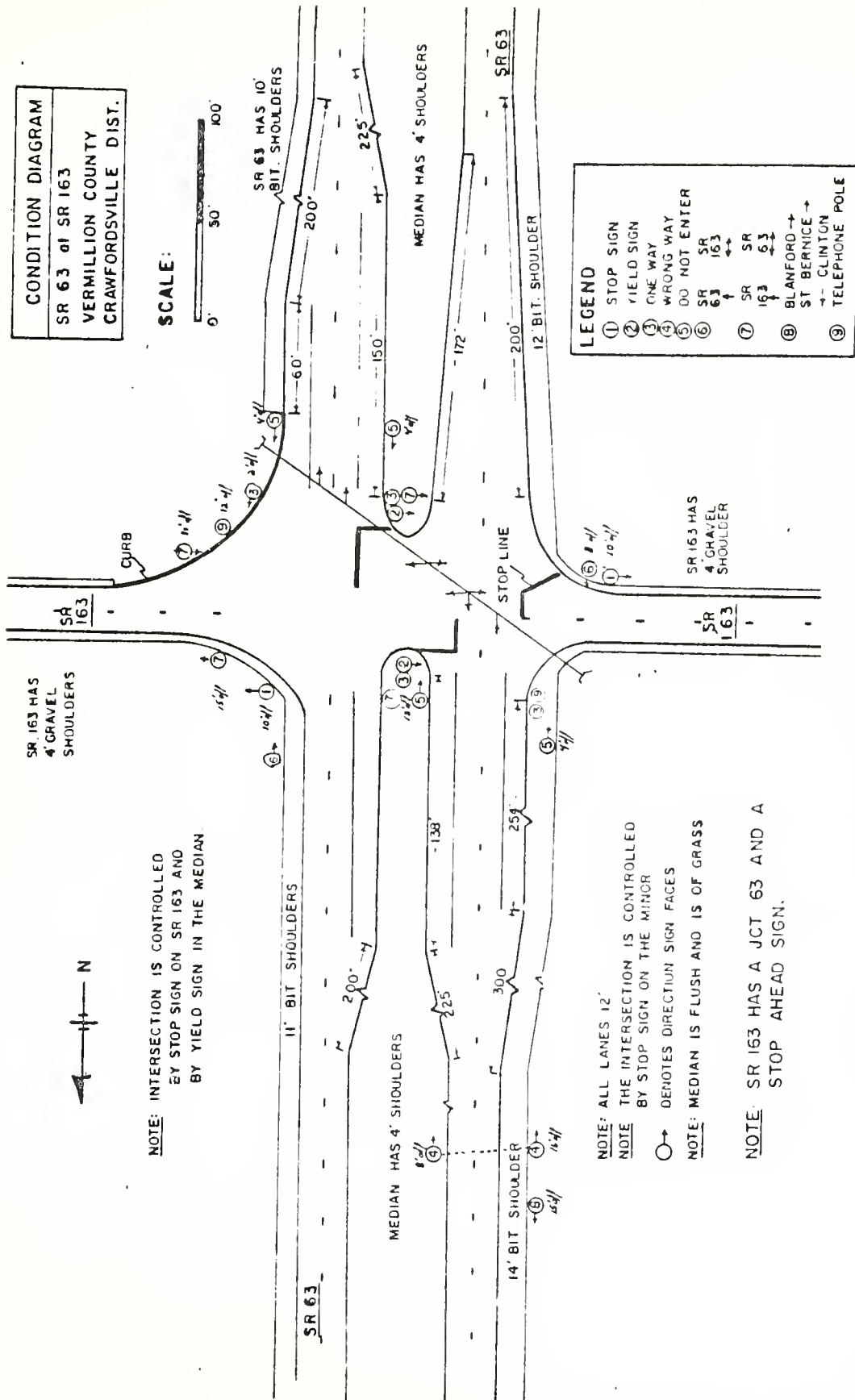


Figure A-1. Condition Diagram of SR 63 at SR 163 (Example)

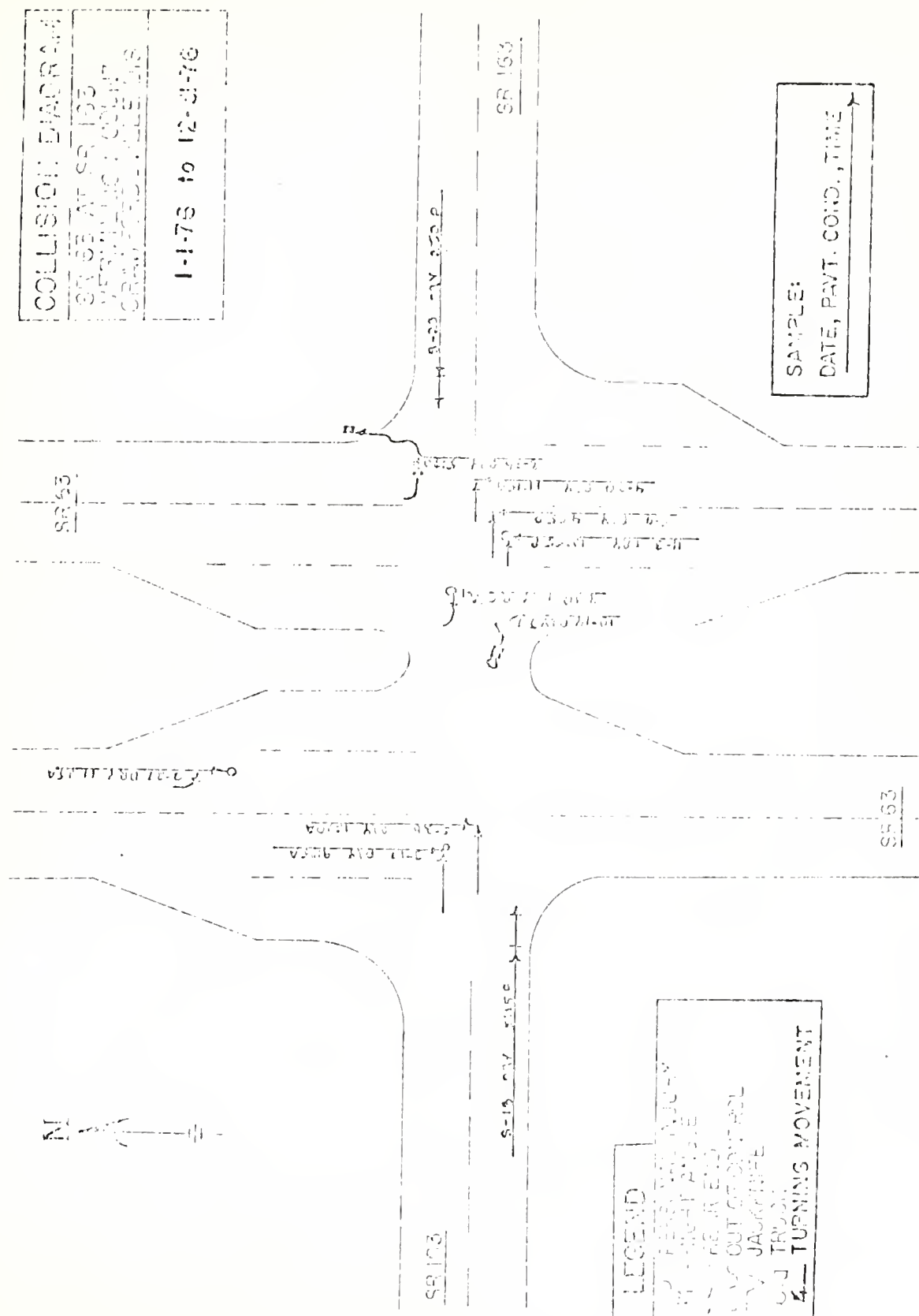


Figure A-2. Collision Diagram of SR 63 at SR 163 (Example)

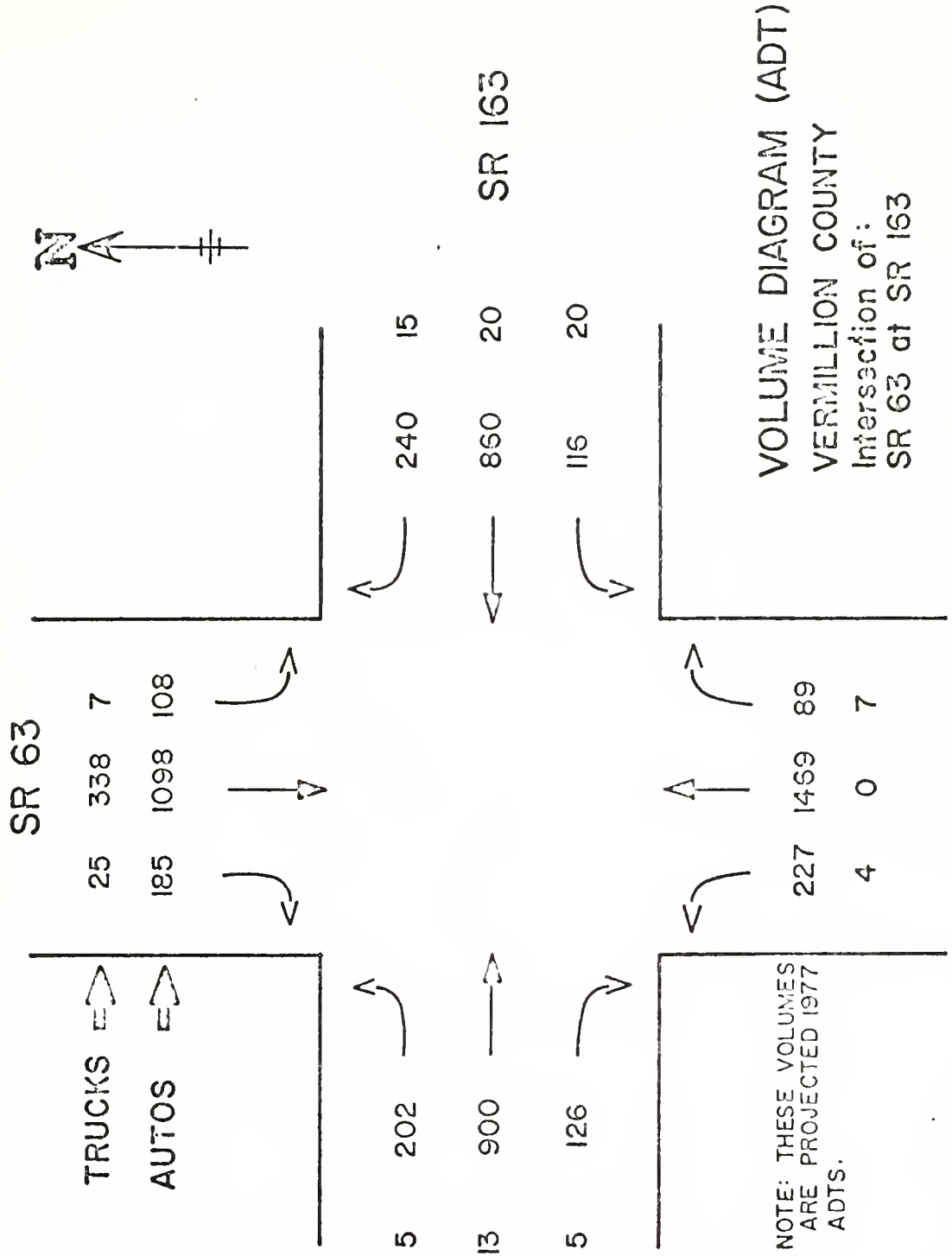


Figure A-3. Traffic Volume Diagram for SR 63 at SR 163 (Example)

HIGH ACCIDENT LOCATION EVALUATION FORMS

TEAM MEMBER'S NAME: _____

LOCATION: _____

TIME: _____ DAY: _____ DATE: _____

WEATHER CONDITIONS: _____

HAVE YOU DISCUSSED THIS SITE WITH ANOTHER MEMBER?

☐ YES ☐ NO

IF YES, EXPLAIN WHAT TRANSPIRED: _____

_____COMMENTS ABOUT INDIVIDUAL LEGS (APPROACHES) OR SECTIONS
(CLEARLY IDENTIFY EACH LEG BY THE DIRECTION OF THE
TRAFFIC MOVEMENT THEREON):1) _____

Figure A-4. Field Evaluation Form

2)

3

Figure A-4. (Continued)

4)

USE SPACE BELOW FOR ANY ADDITIONAL APPROACHES WHICH
MAY EXIST.

COMMENTS OR OBSERVATIONS WHILE TRYING TO VISUALIZE THE
GIVEN VOLUMES OR THE ACCIDENTS WHICH HAVE OCCURRED:

OBSERVATIONS OF POTENTIAL HAZARDS, NEAR-ACCIDENTS OR
SAFETY VIOLATIONS: _____

ADDITIONAL COMMENTS OR OBSERVATIONS: _____

COMPLETE A COPY OF THIS FORM FOR EACH IDENTIFIED
ACCIDENT TYPE

ACCIDENT TYPE: _____

OF ALL IDENTIFIABLE ACCIDENT TYPES, THE ABOVE ACCIDENT
TYPE IS RANKED ____ OF ____ IN IMPORTANCE

POSSIBLE CAUSES AND THE PROPOSED COUNTERMEASURES
IN ORDER OF DECREASING IMPORTANCE

CAUSE 1) _____

COUNTERMEASURE 1) _____

COUNTERMEASURE 2) _____

COUNTERMEASURE 3) _____

COUNTERMEASURE 4) _____

COUNTERMEASURE 5) _____

CAUSE 2) _____

COUNTERMEASURE 1) _____

COUNTERMEASURE 2) _____

Figure A-5. Summary Form for Accident Type, Causal Factor and Countermeasures

COUNTERMEASURE 3) _____

COUNTERMEASURE 4) _____

COUNTERMEASURE 5) _____

CAUSE 3) _____

COUNTERMEASURE 1) _____

COUNTERMEASURE 2) _____

COUNTERMEASURE 3) _____

COUNTERMEASURE 4) _____

COUNTERMEASURE 5) _____

CAUSE 4) _____

COUNTERMEASURE 1) _____

COUNTERMEASURE 2) _____

COUNTERMEASURE 3) _____

Figure A-5. (Continued)

COUNTERMEASURE 4) _____

COUNTERMEASURE 5) _____

CAUSE 5) _____

COUNTERMEASURE 1) _____

COUNTERMEASURE 2) _____

COUNTERMEASURE 3) _____

COUNTERMEASURE 4) _____

COUNTERMEASURE 5) _____

ADDITIONAL COMMENTS AND OBSERVATIONS: _____

Figure A-5. (Continued)

Checklist

Have you . . .

- _____ noted if you discussed this site with another team member?
- _____ reviewed the materials at the location?
- _____ checked to see if everything is correct on the condition diagram?
- _____ driven all the approaches or legs at the location at least once?

- _____ filled in the comment and observation sheet relative to the driving process completely?
- _____ transferred all your recorded material to the report forms?
- _____ determined the primary and other accident types?
- _____ determined the causal factors for each accident type?
- _____ determined useful countermeasures for each accident type?

Figure A-6. Field Checklist

LOCATION EVALUATION

Location: _____

Accident Type: _____

Cause: _____

Countermeasure: _____

Countermeasure: _____

Countermeasure: _____

Countermeasure: _____

Countermeasure: _____

Countermeasure: _____

CTE _____ DTE _____ Rank _____ Degree of Agreement _____
 LTE _____ HFM _____

Figure A-7. Site Evaluation Form by Accident Type, Causal Factor and Countermeasures

Table A-1. 1976 Accident Summary Table for SR 63 at SR 163 (Example)

ACCIDENT

SUMMARY

LOCATION:	SR 63 at SR 163
	Vermillion
PERIOD:	1-1-76 to 12-31-76
DISTRICT:	Crawfordsville

TOTAL ACCIDENTS	DAY	DARK
11	11	

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
4	7		9	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
2	5		L= 4 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
11			

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
1		2	3	2	3	

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								1		2		3	6
PM	1		1		1	2							5

APPENDIX AA: JOB DESCRIPTIONS FOR THE FIVE MEMBER MULTIDISCIPLINARY
TEAM FOR THE INVESTIGATION OF HIGH ACCIDENT LOCATIONS ON
STATE HIGHWAYS IN INDIANA

1) Team Leader - The team leader should be a professional engineer from the Traffic Division of the Indiana State Highway Commission (ISHC) with a minimum of five years experience. The experience should include geometric design, accident investigation and traffic operations. This person should have knowledge of the procedures of accident investigations.

The team leader must have leadership qualities and be able to direct the activities of a team of four other professionals.

2) Team Member - This member should be from the office of the ISHC district where the high accident site is located. He should be a traffic engineer and should have a minimum of five years of experience in traffic engineering and be knowledgeable in intersection design, traffic control devices and their warrants.

3) Team Member - The third member should be a local traffic engineer. This member should be the traffic engineer or the person in charge of traffic engineering matters in a city near the accident location.

This person should have an engineering degree, preferably with specialization in a transportation field. This person should have five

years of engineering experience, with at least three of these years in the transportation area.

4) Team Member - This member should be the human factors expert for the team with a graduate degree in Psychology, Sociology or some other human factors related field. Any of this education which has dealt specifically with the driver would be considered an additional asset. This member should have five years of experience in his field.

5) Team Member - The fifth member should be a local law enforcement officer. This member should have a high school diploma. The individual should have served as a law enforcement officer for at least five years and in the specific area of traffic operations or safety for at least three years. The major contribution to the team will be his knowledge of traffic regulations, accident investigations and law enforcement.

APPENDIX B

DESCRIPTION, TEAM EVALUATION, AND FIELD DATA
FOR SR 63 at SR 163

APPENDIX B: DESCRIPTION, TEAM EVALUATION, AND
FIELD DATA FOR SR 63 AT SR 163

Description of SR 63 at SR 163

The intersection of SR 63 at SR 163 is in Vermillion County and in the Crawfordsville ISHC district. It is located approximately one mile West of Clinton, Indiana. It is situated in a rural environment.

SR 63 is a basic four-lane divided highway where SR 163 is a two-lane roadway. The intersection is controlled on SR 163 by stop signs and in the median by yield signs. There are flashers hung diagonally across the intersection. The speed limit on SR 163 is 50 m.p.h. while it is 55 m.p.h. on SR 63.

Team Evaluation of SR 63 at SR 163

This intersection was discussed at a meeting of the Independent team. The result of this meeting was a team consensus though other opinions were expressed. It should be noted below that the causal factors are ranked in order of importance whereas the countermeasures are not rank-ordered. The human factors person was not present at this meeting, so the team consensus is based on a four-man team.

Accident Type 1. Right Angle

Cause 1. Poor Visibility of flashers on SR 63.

Countermeasure 1. Increase the wattage of the lamps in the flashers.

Countermeasure 2. Place the flashers along the lane lines instead of in the middle of the lane in order to minimize obstruction of visibility by trucks.

Countermeasure 3. Install a third flasher that focuses further down the road than the others.

Cause 2. Inadequate warning to SR 163 traffic of the four-lane divided SR 63 traffic.

Countermeasure 1. Install an auxiliary sign on the stop sign approach on SR 163 that indicates multilane flow.

Countermeasure 2. Install oversize advance warning signs.

Cause 3. Left turning drivers are confused by the oncoming left turning traffic, in part because of length of median opening.

Countermeasure 1. Instead of left turning lanes, cut left turning slots through the median so the Northbound and Southbound left turning traffic are not opposing each other.



Northbound on SR 63 at the Intersection of SR 63 at SR 163



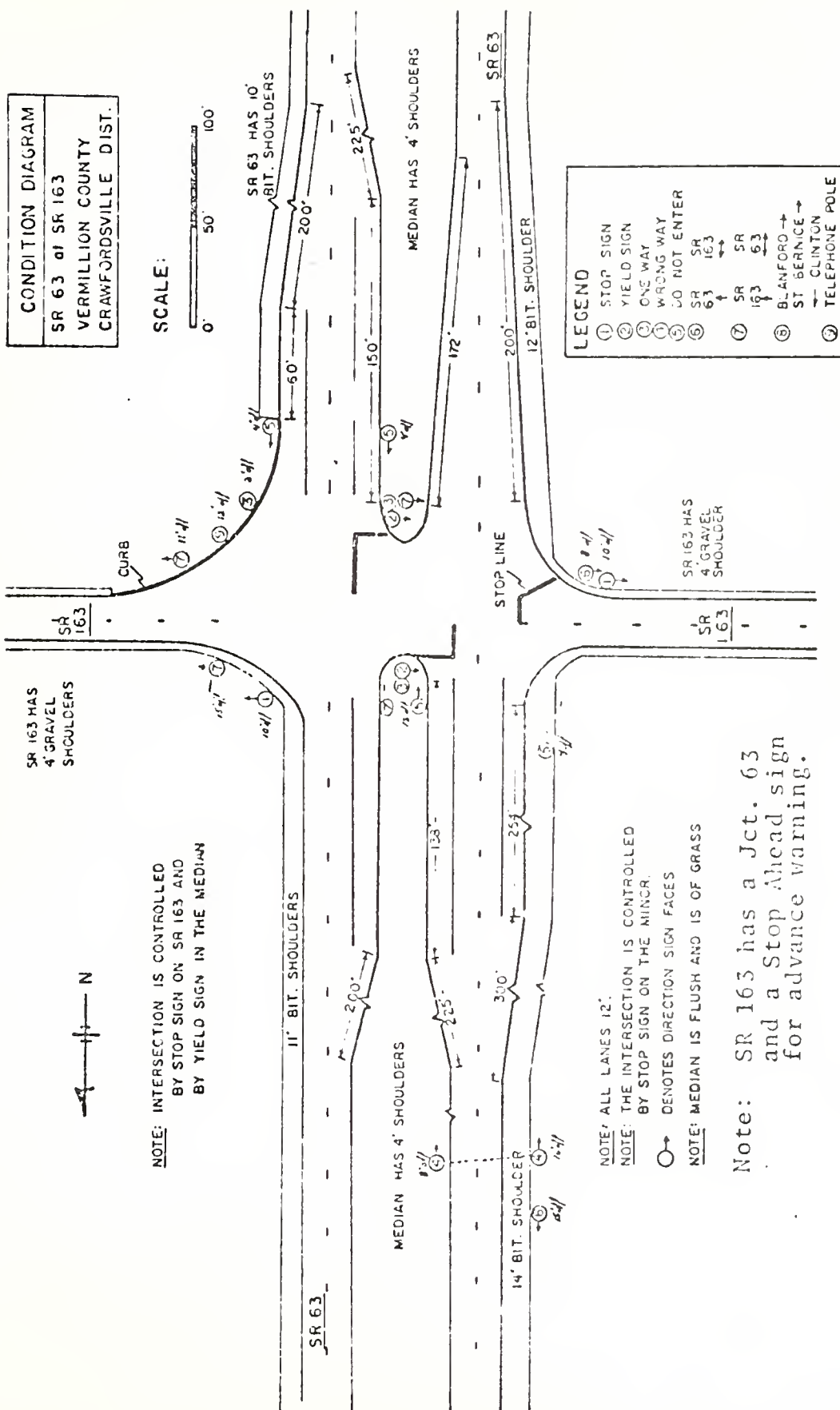
Southbound on SR 63 at the Intersection of SR 63 at SR 163



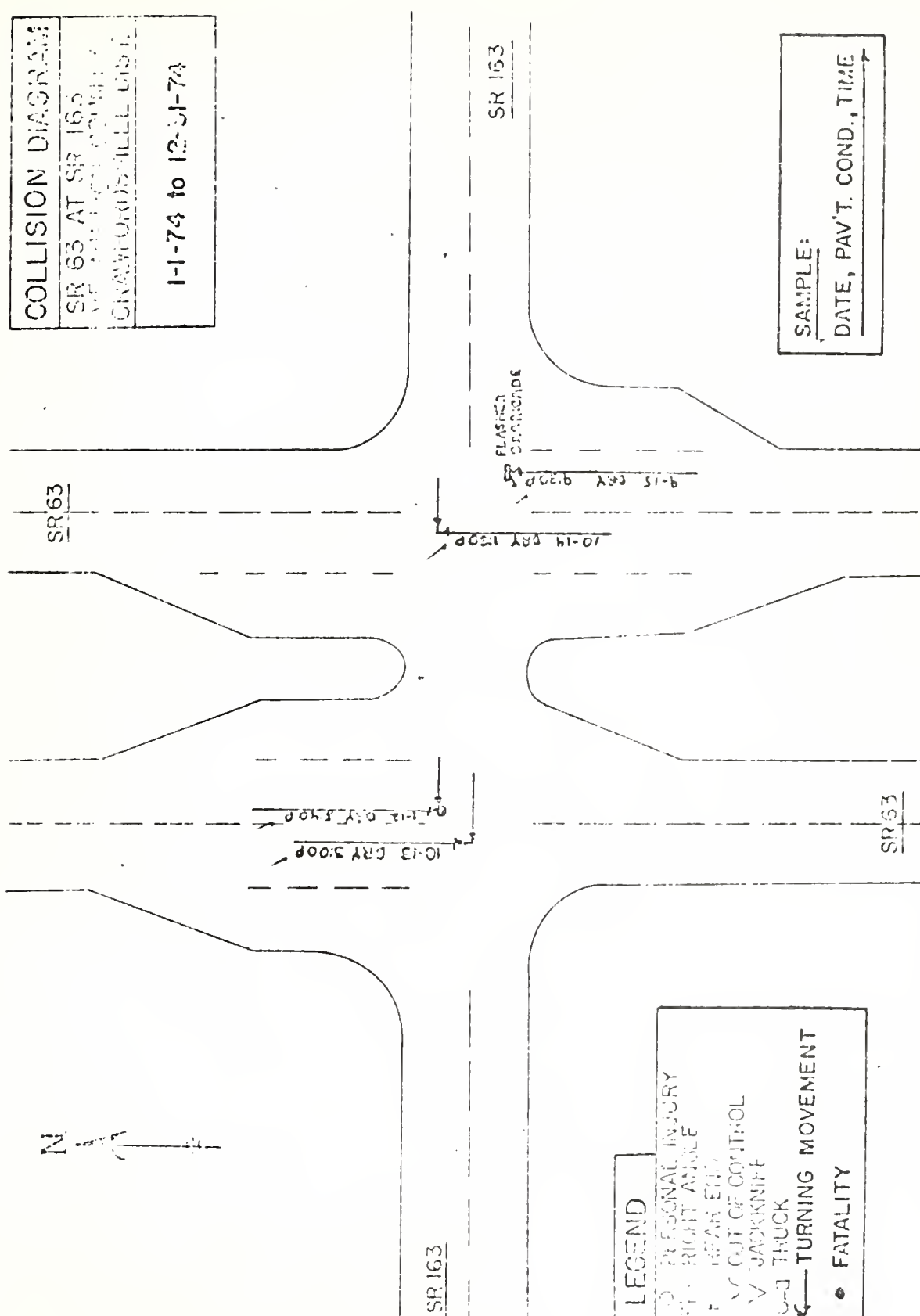
Eastbound on SR 163 at the Intersection of SR 63 at SR 163



Westbound on SR 163 at the Intersection of SR 63 at SR 163



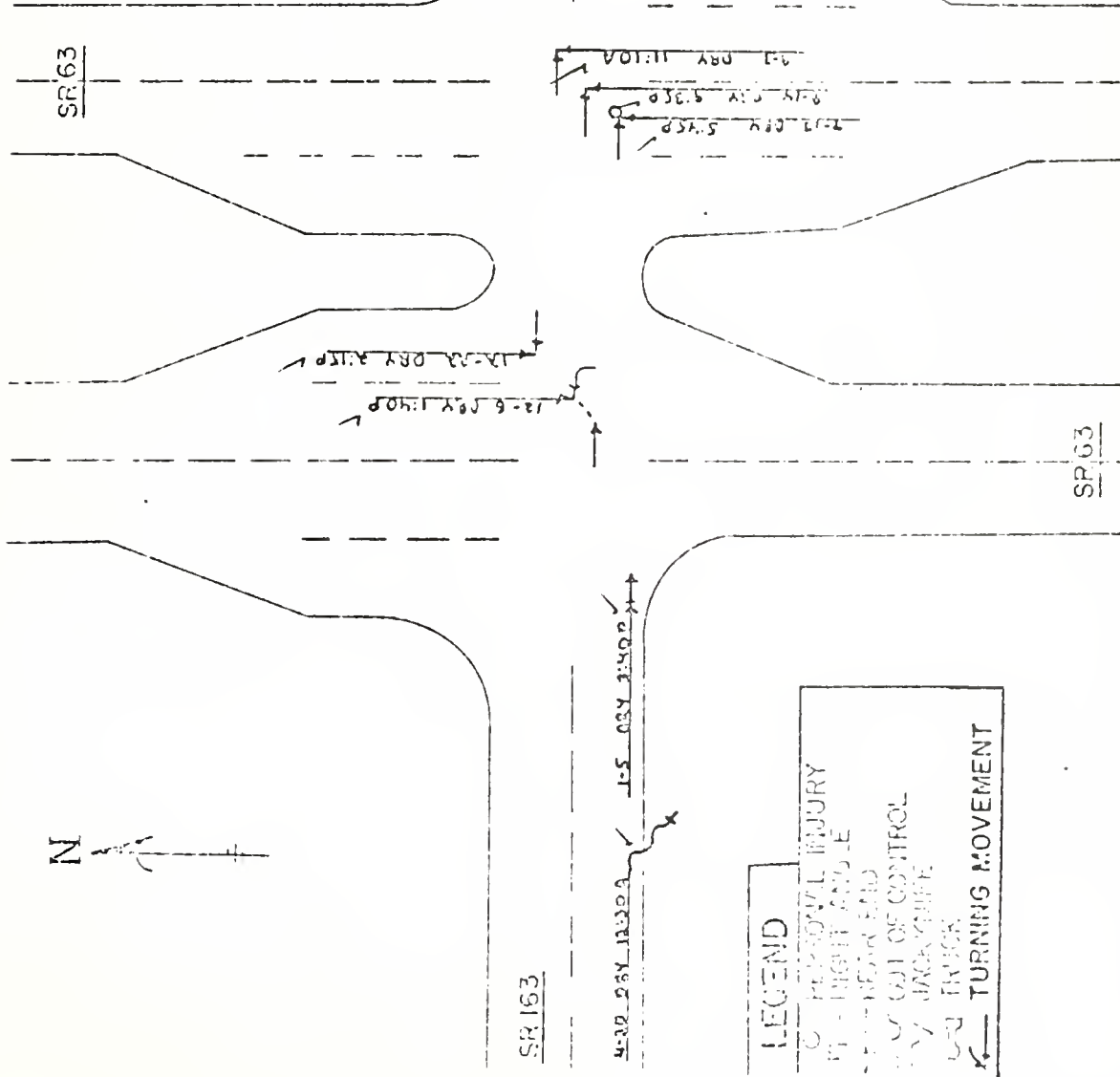
COLLISION DIAGRAM
SR 63 AT SR 163
CONANTONVILLE, TENN.
1-1-74 to 12-31-74

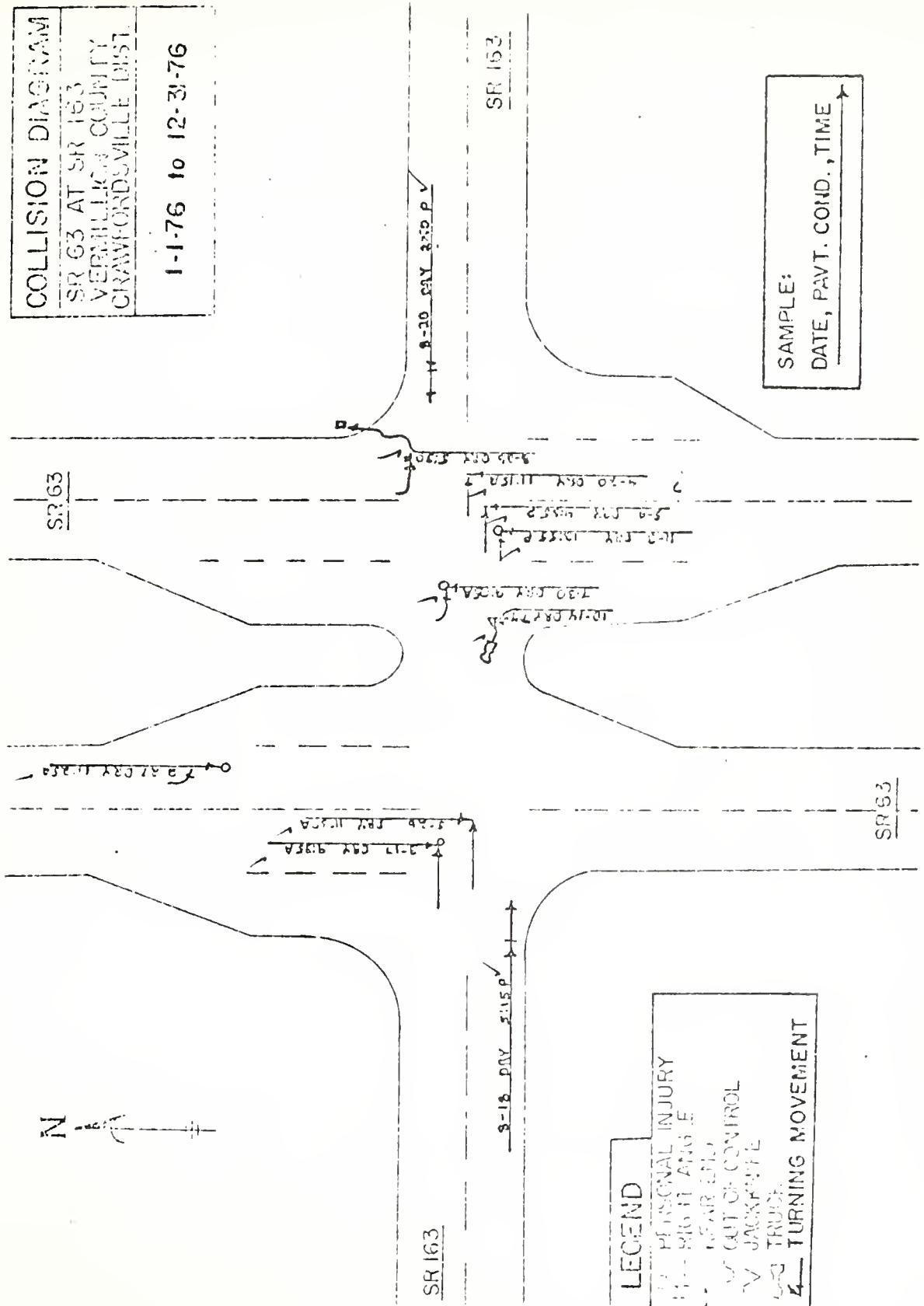
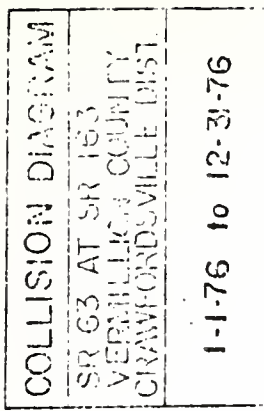


COLLISION DIAGRAM
 SR 63 AT SR 163
 GREENSBORO COUNTY
 GREENSBOROVILLE DIST.

1-1-75 to 12-31-75

SAMPLE:
 DATE, PAVT. COND., TIME





ACCIDENT

SUMMARY

LOCATION: SR 63 at SR 163

Vermillion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Crawfordsville

TOTAL ACCIDENTS	DAY	NIGHT
4	2	2

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
	3	1	2	3

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
	3		1 = 1

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
3	1		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	1					1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM													0
PM		1		1		1				1			4

ACCIDENT

SUMMARY

LOCATION: SR 63 at SR 163

Vermillion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Crawfordsville

TOTAL ACCIDENTS	DAY	DARK
7	6	1

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
1	6		2	

REAR END	RIGHT ANGLE	CUT OF CONTROL	TURNING MOVEMENT
1	4		L= 1 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
7			

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	1		1	1		1

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1									1		1	3
PM		1	1	1		1							4

ACCIDENT

SUMMARY

LOCATION: SR 63 at SR 163

Vermillion

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Crawfordsville

TOTAL
ACCIDENTS

11

DAY

DARK

11

PERSONAL
INJURY

4

PROPERTY
DAMAGE

7

FATAL

INJURED

9

KILLED

REAR END

2

RIGHT ANGLE

5

OUT OF
CONTROLTURNING
MOVEMENT

L= 4 R=

SIDE SWIPE

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

11

WET

SNOW/ICE

OTHER

SUN.

1

MON.

TUES.

2

WED.

3

THUR.

2

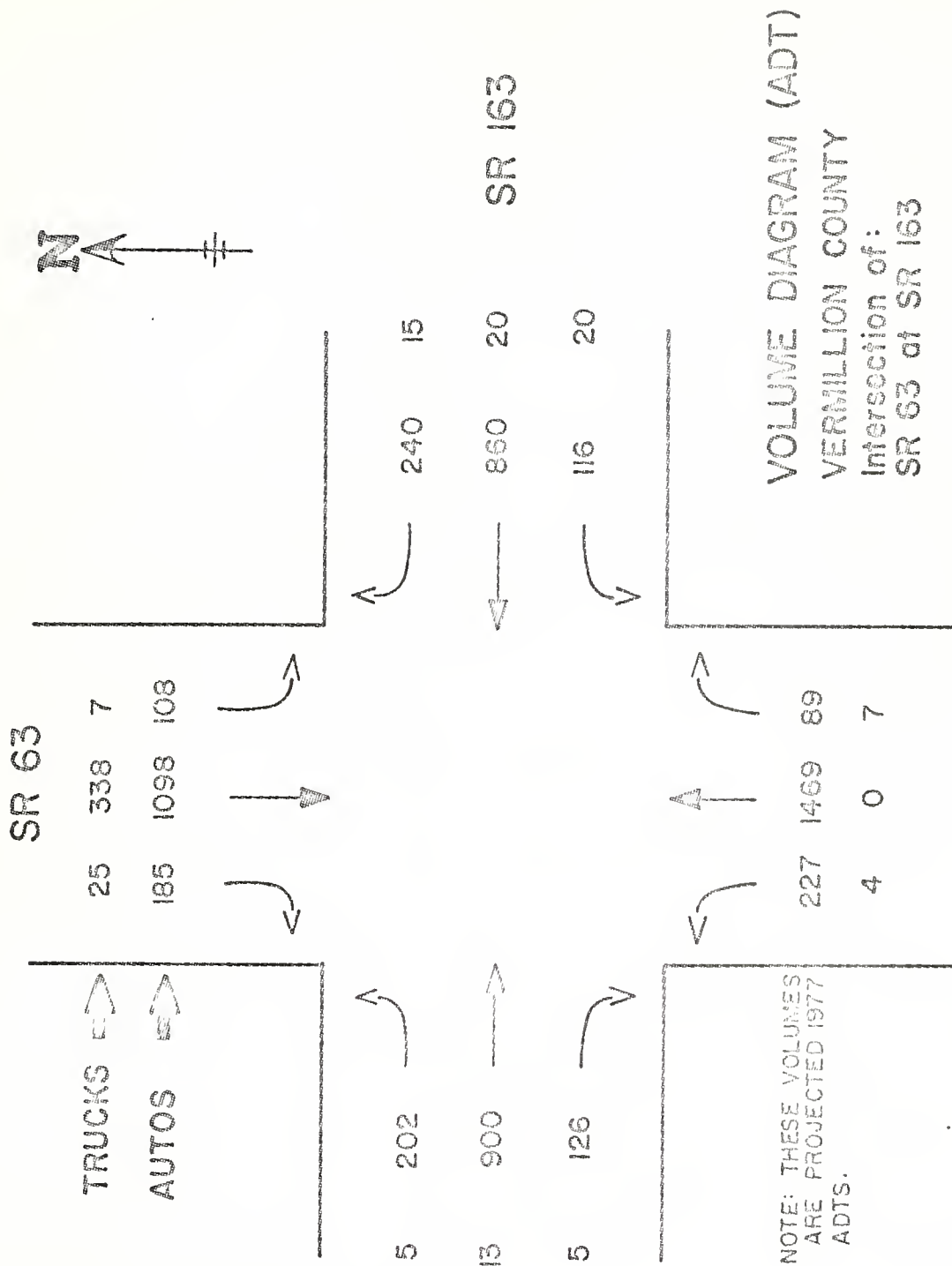
FRI.

3

SAT.

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								1		2		3	6
PM	1		1		1	2							5



APPENDIX C

DESCRIPTION, TEAM EVALUATION, AND FIELD DATA
FOR US 41 AT 45TH AVENUE

APPENDIX C: DESCRIPTION, TEAM EVALUATION, AND
FIELD DATA FOR US 41 AT 45TH AVENUE

Description of US 41 at 45th Avenue

The intersection of US 41 at 45th Avenue is in Lake County and in the LaPorte district. This intersection is located in the outskirts of the city of Highland, Indiana. This location is in a basically suburban-urban area.

US 41 is an undivided four-lane highway that has left turn bays. 45th Avenue is an undivided four-lane suburban street at the intersection. The site is controlled by a signal activated by traffic on 45th Avenue. The speed limit on US 41 is 45 m.p.h. and 35 m.p.h. on 45th Avenue.

Team Evaluation of US 41 at 45th Avenue

A meeting of the Independent team discussing the problems and possible solutions for this site yielded the following team consensus as to predominant accident types, causal factors and countermeasures. It should be noted that the human factors person could not attend this meeting, so the results are based on a four-person team.

Accident Type 1. Rearend

Cause 1. Poor signal visibility.

Countermeasure 1. Install the signals in a box configuration instead of diagonally across the intersection as at present.

Cause 2. Insufficient advance warning.

Countermeasure 1. Erect an overhead structure with a Signal Ahead sign on it with an auxiliary sign announcing 45th Avenue.

Countermeasure 2. Install Speed Limit reduction signs.

Cause 3. Slick pavements.

Countermeasure 1. Check skid resistance and repave if necessary.

Accident Type 2. Left Turning Movement

Cause 1. Improper signal timing.

Countermeasure 1. Shorten the amber phase and all red phase.

Countermeasure 2. Install a Wait-Delayed Signal sign facing US 41 through traffic.

Cause 2. Driver confusion as to lane usage.

Countermeasure 1. Paint arrows as well as lane lines on pavement.



Northbound on US 41 at the Intersection of US 41 and 45th Street



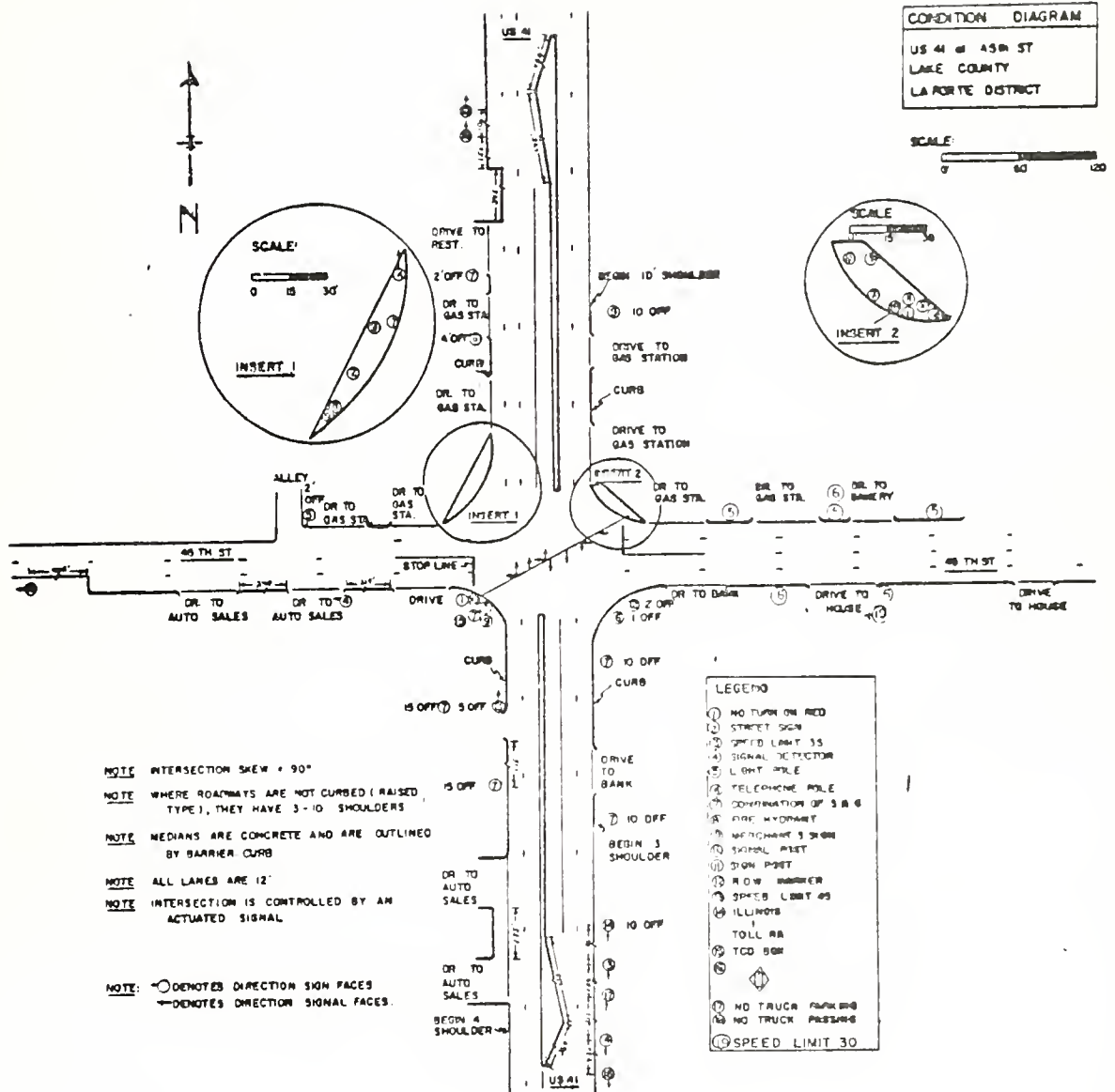
Southbound on US 41 at the Intersection of US 41 and 45th Street



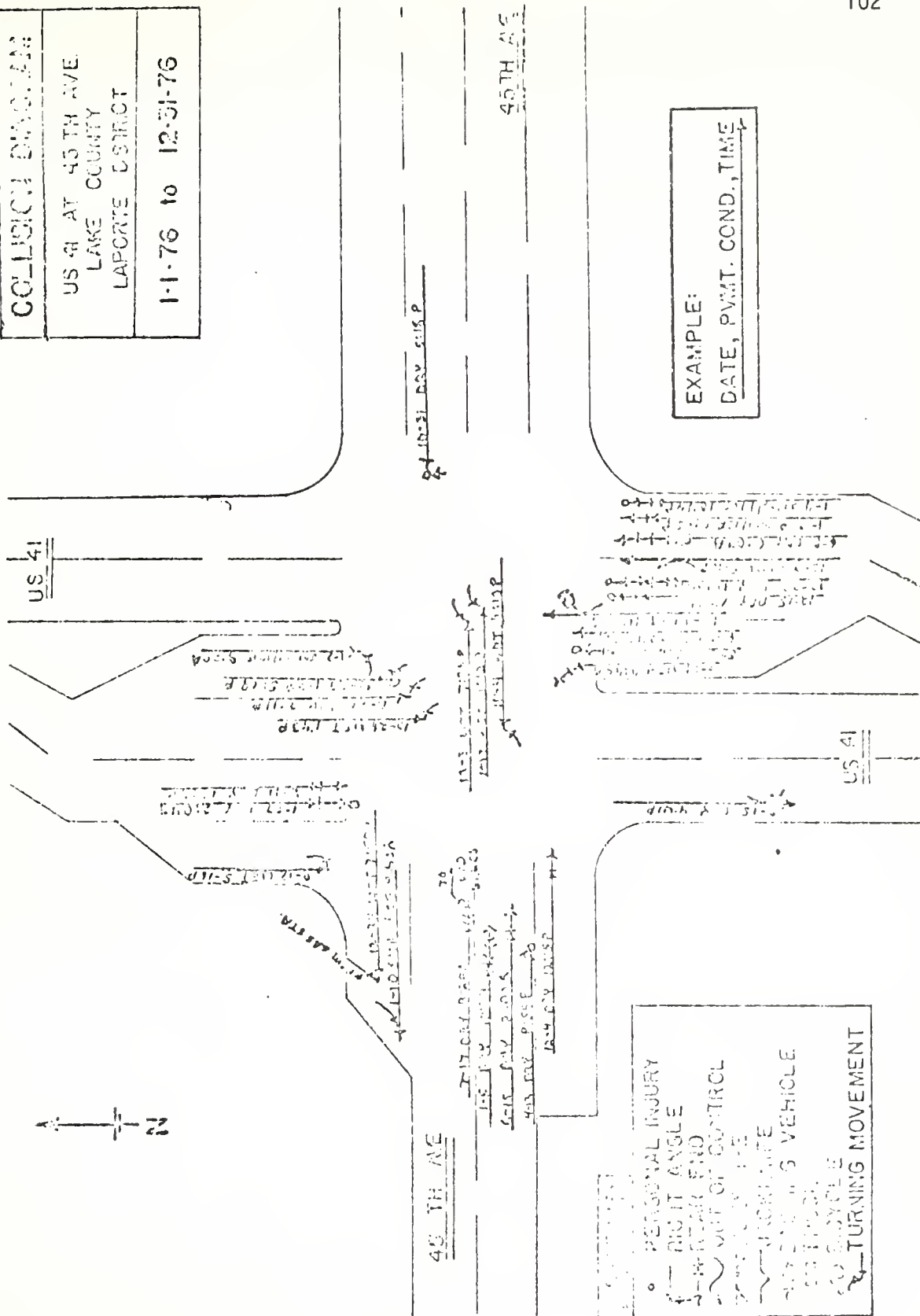
Eastbound on 45th Street at the Intersection of US 41 and 45th Street



Westbound on 45th Street at the Intersection of US 41 and 45th Street



COLLISION DIAGRAM	
US 41 AT 45TH AVE LAKE COUNTY LAPOORTE DISTRICT	1-1-76 to 12-31-76



EXAMPLE:
DATE, PM/MT. COND., TIME

- PERSONAL INJURY
- DRIFT ANGLE
- WHEEL END
- OUT OF CONTROL
- WHEEL OFF
- WHEEL OFF VEHICLE
- WHEEL OFF CYCLE
- TURNING MOVEMENT

ACCIDENT

SUMMARY

LOCATION: US 41 (Indianapolis Blvd.) at 45th
Street in Highland, In
Lake County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: LaPorte

TOTAL ACCIDENTS	*1 NOT RECORDED	
	DAY	DARK
37	24	12

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	28		13	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
21	9		L=1 R=1

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
4			1

ROAD CONDITION				*1 NOT RECORDED
DRY	WET	SNOW/ICE	OTHER	
24	9	3		

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	4	7	3	7	5	8

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1		1							3	1	4	10
PM	3	2	2	3	2	7	1	1			2	4	27

ACCIDENT

SUMMARY

LOCATION: US 41 (Indianapolis Blvd.) at 45th
Street in Highland, IN
Lake County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: LaPorte

TOTAL ACCIDENTS	DAY	DARK
40	29	11

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	31		14	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
18	4	2	L= 9 R= 2

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
32	5	3	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	7	8	6	3	6	7

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1						2	1	3	6	2	2	17
PM	2	2	1	1	3	1	1	4	2	2	2	1	22

ACCIDENT

SUMMARY

LOCATION: US 41 (Indianapolis Blvd.) at 45th
Street in Highland, IN
Lake County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: LaPorte

TOTAL ACCIDENTS	DAY	DARK
29	20	9

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
8	21		14	

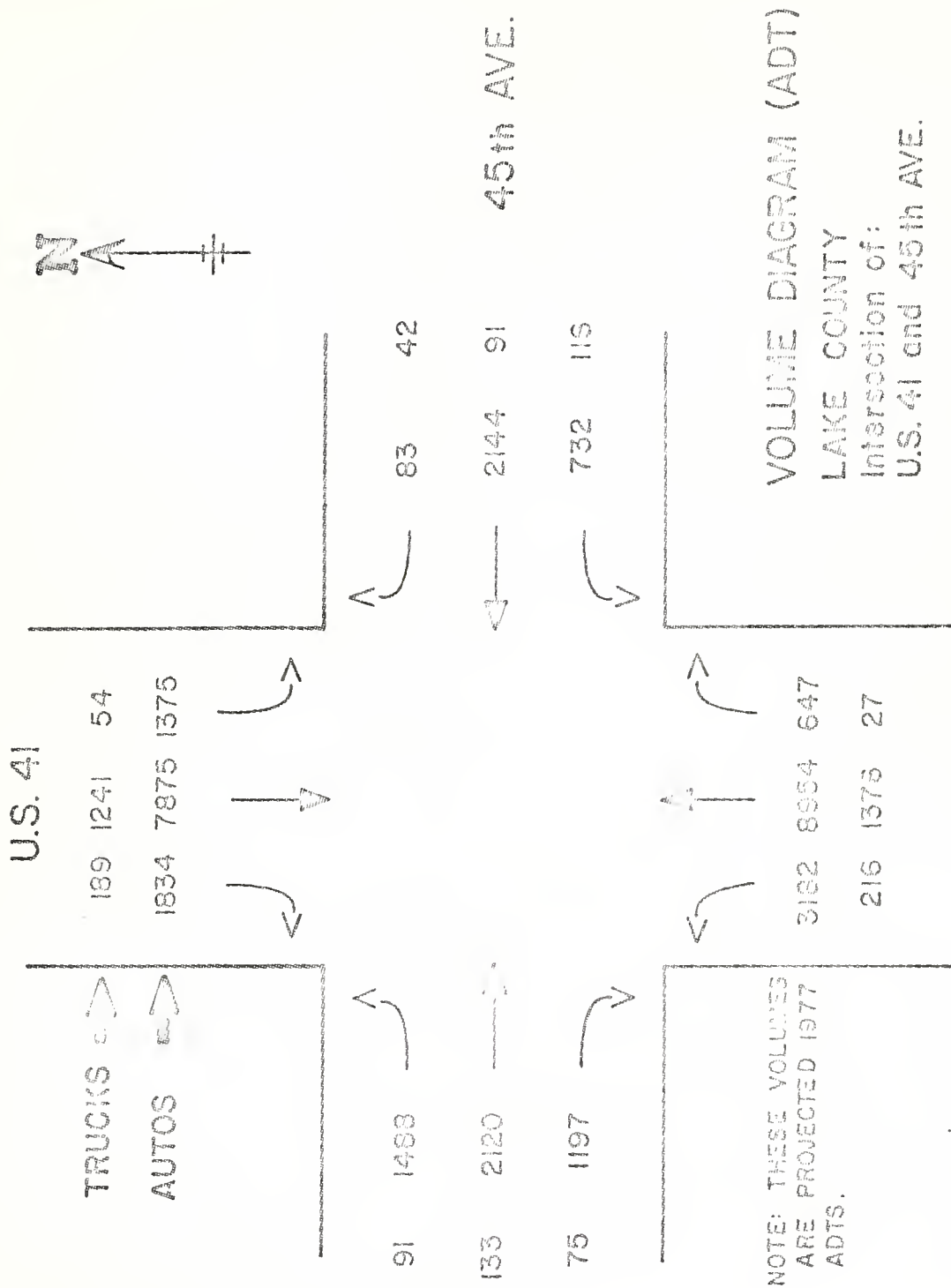
REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
12	1		L= 11 R= 2

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
18	7	4	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	2	7	5	4	3	5

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM		1	2				1	1	1	3		2	11
PM	1	3	1		1	6		2	2		2		18



APPENDIX D

DESCRIPTION, TEAM EVALUATION AND
FIELD DATA FOR US 31 AT SR 38

APPENDIX D: DESCRIPTION, TEAM EVALUATION, AND
FIELD DATA FOR US 31 AT SR 38

Description of US 31 at SR 38

The intersection of US 31 at SR 38 is in Hamilton County and in the Greenfield district. It is located approximately seven miles South of Kokomo, Indiana. The site is in a rural area. The intersection is situated at the sag of a vertical curve.

US 31 is a four-lane divided highway with left turn deceleration lanes. There are no right turn lanes though this turning movement is channelized by islands. SR 38 is a two-lane road.

The intersection is stop controlled on SR 38 and by yield signs in the median. There are signals hung by cable diagonally across the intersection though they are on continuous flash operation. The speed limit of US 31 is 55 m.p.h.

Team Evaluation of US 31 at SR 38

The Indianapolis team met to discuss this site and form a team consensus as to the accident types, causal factors and countermeasures. The central office traffic engineer was not present, consequently the analysis is based on a four-man team. It should be noted that the countermeasures are simply listed and not rank ordered.

Accident Type 1. Right Angle

Cause 1. Poor visibility of the intersection.

Countermeasure 1. Reduce grades on US 31.

Countermeasure 2. Activate signal between 7:00 a.m. and 7:00 p.m. and operate as flasher at other hours.

Countermeasure 3. Increase advance warning distance and install flashers on these signs.

Countermeasure 4. Enlarge the lens size of the flashing signals at the intersection

Countermeasure 5. Add a strobe to the flashing signal lights.

Countermeasure 6. Double the flashing signal heads by placing one on top of the other.

Countermeasure 7. Install an advance warning with a flasher that is activated when the fixed-timed signal is operating and is in the amber or red phase.

Accident Type 2. Rearend

Cause 1. The wide distribution of speed on US 31 caused by right turning vehicles.

Countermeasure 1. Construct right turn lanes on US 31.

Countermeasure 2. Eliminate the curbs in the four quadrants of the intersection.



Northbound on US 31 at the Intersection of US 31 at SR 38



Southbound on US 31 at the Intersection of US 31 at SR 38



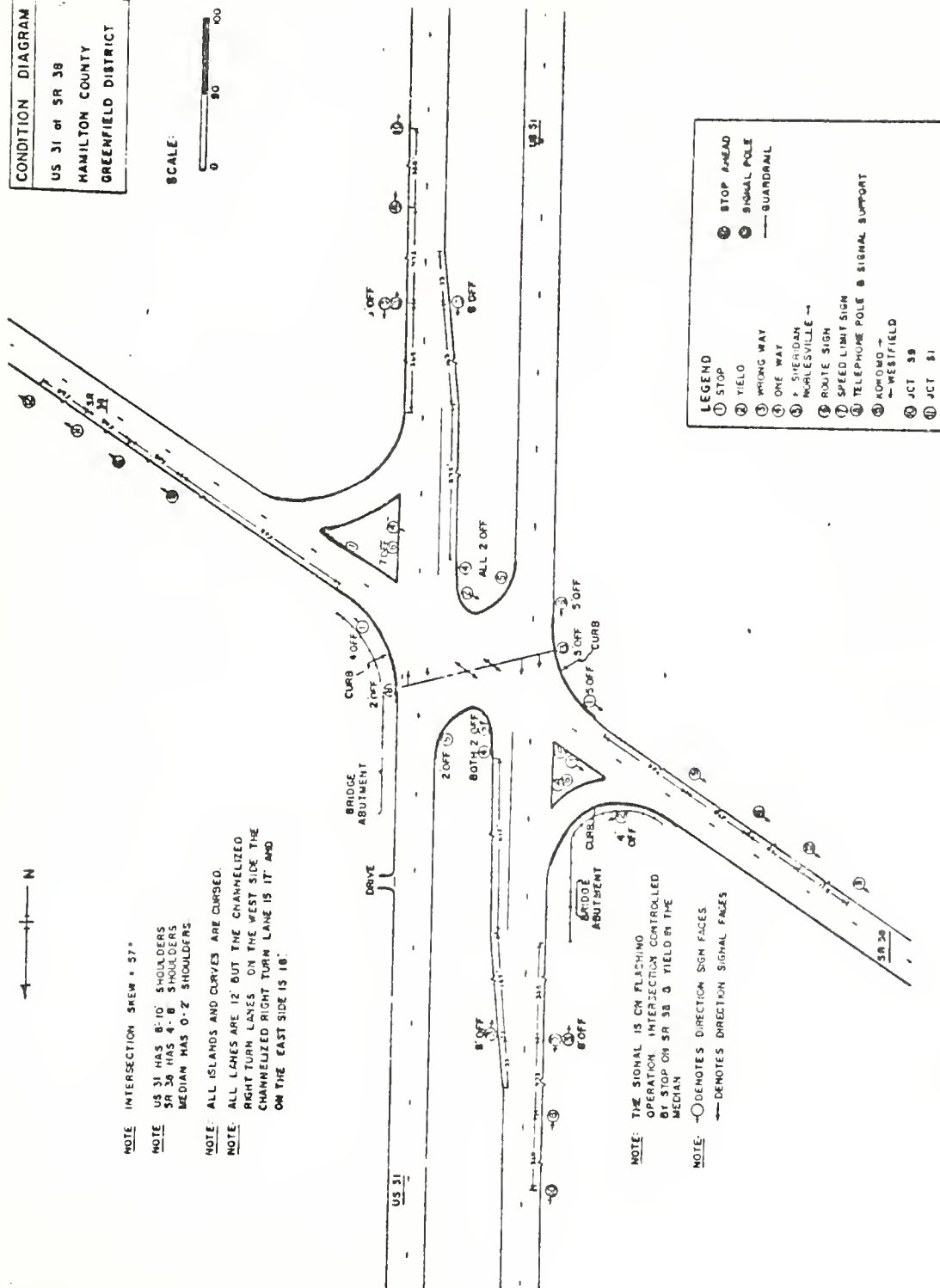
Eastbound on SR 38 at the Intersection of US 31 at SR 38



Westbound on SR 38 at the Intersection of US 31 at SR 38

CONDITION DIAGRAM
US 31 at SR 38
HAMILTON COUNTY
GREENFIELD DISTRICT

SCALE:



- LEGEND
- ① STOP
 - ② YIELD
 - ③ WRONG WAY
 - ④ ONE WAY
 - ⑤ SHERIDAN MARLESVILLE →
 - ⑥ ROUTE SIGN
 - ⑦ SPEED LIMIT SIGN
 - ⑧ TELEPHONE POLE & SIGNAL SUPPORT
 - ⑨ KOWMO →
 - ⑩ WESTFIELD
 - ⑪ JCT 38
 - ⑫ JCT 31
 - ⑬ STOP AHEAD
 - ⑭ SIGNAL POLE
 - GUARDRAIL

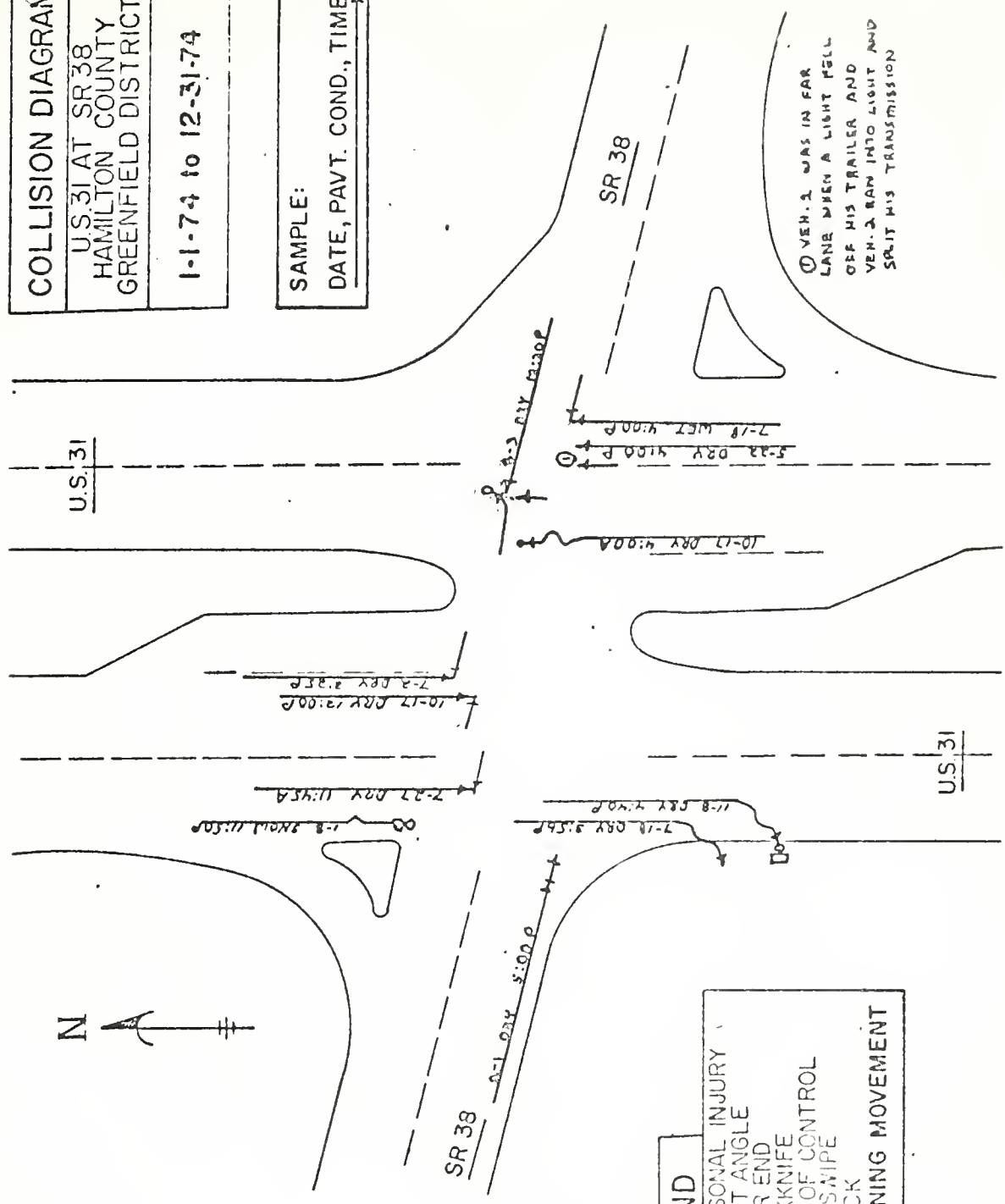
COLLISION DIAGRAM

U.S. 31 AT SR 38
HAMILTON COUNTY
GREENFIELD DISTRICT

1-1-74 to 12-31-74

SAMPLE:

DATE, PAVT. COND., TIME



LEGEND

O PERSONAL INJURY

4/4 RIGHT ANGLE

4/4 REAR END

4/4 JACKKNIFE

4/4 OUT OF CONTROL

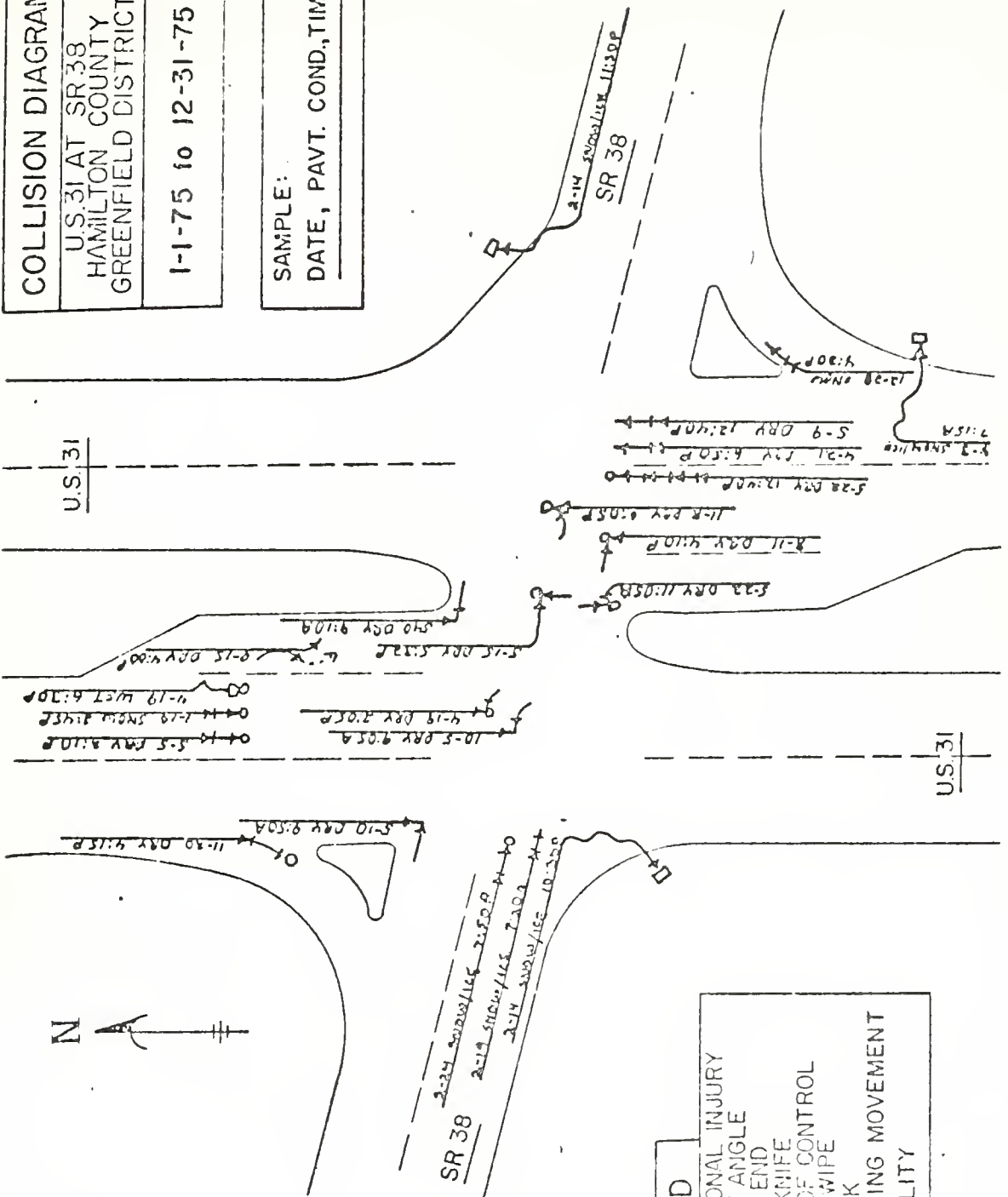
4/4 SIDESWIPE

4/4 TRUCK

4/4 TURNING MOVEMENT

COLLISION DIAGRAM
U.S. 31 AT SR 38
HAMILTON COUNTY
GREENFIELD DISTRICT
1-1-75 to 12-31-75

SAMPLE:
DATE, PAVT. COND., TIME →



ACCIDENT

SUMMARY

LOCATION: US 31 at SR 38

Hamilton County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield District

TOTAL ACCIDENTS	DAY	DARK
22	21	1

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	12	1	20	1

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
9	4	4	L= 5 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
14	1	7	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	5	1	1	5	3	4

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM								2		3		1	6
PM	1		4		4	1	3	1			1	1	16

ACCIDENT

SUMMARY

LOCATION: US 31 at SR 38

Hamilton County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS		DAY		DARK	
13		7		6	

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
7	6		12	

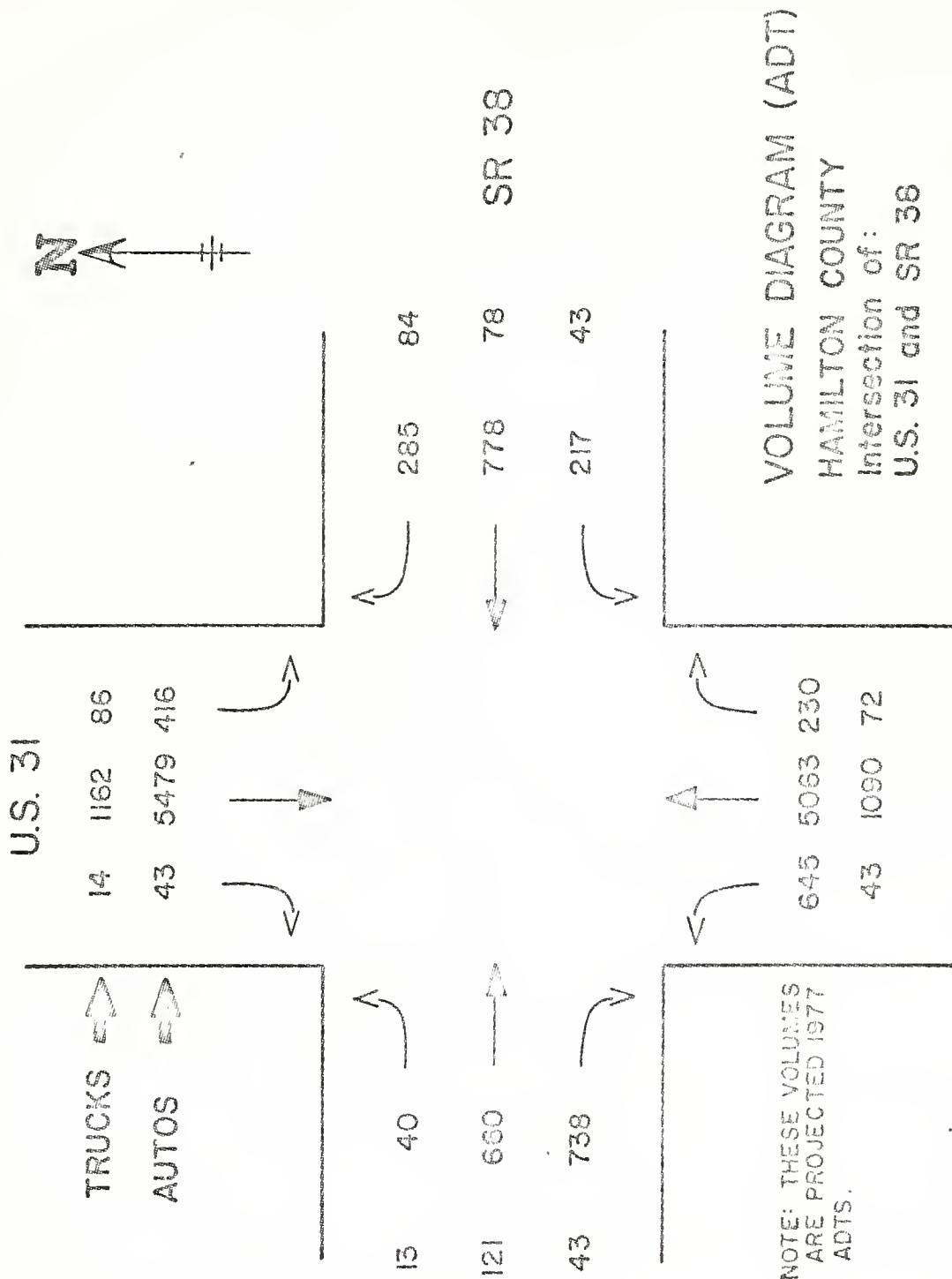
REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
4	6		L= R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
8	1	4	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	4	1			4	2

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	3							1	3				7
PM			1	1	1		1	1	1				6



APPENDIX E

DESCRIPTION, TEAM EVALUATION, AND FIELD DATA
FOR SR 67 AT FRANKLIN ROAD

APPENDIX E: DESCRIPTION, TEAM EVALUATION, AND
FIELD DATA FOR SR 67 AT FRANKLIN ROAD

Description of SR 67 at Franklin Road

The intersection of SR 67 at Franklin Road is in Marion County and in the Greenfield district. It is located in the city of Lawrence which is a Northeast suburb of Indianapolis. This site is in a suburban area.

SR 67 is a four-lane undivided highway that has left turn bays at the intersection. Franklin Road on the North approach is a four-lane suburban street. Franklin Road on the South approach is a two-lane suburban street with a right turn lane at the intersection. Both roads have many driveways entering them. There is a fifty-nine degree skew between the roadways. The intersection is controlled by a fixed time signal.

Team Evaluation of SR 67 and Franklin Road

The Indianapolis team met to discuss the evaluation of this intersection. The ISHC central office traffic engineer was not present at this meeting so the analysis is the consensus of a four-person team.

Accident Type 1. Left Turning Movement

Cause 1. High volumes of traffic on SR 67.

No countermeasures were suggested as to how to alleviate the high volumes.

Cause 2. Poor signal visibility.

Countermeasure 1. Erect signals in a box configuration instead of diagonally as they presently are.

Cause 3. Too much driveway access.

Countermeasure 1. Widen Franklin Road.

Countermeasure 2. Paint lane lines on pavement.



Eastbound on SR 67 at the Intersection of SR 67 and Franklin Road



Westbound on SR 67 at the Intersection of SR 67 and Franklin Road

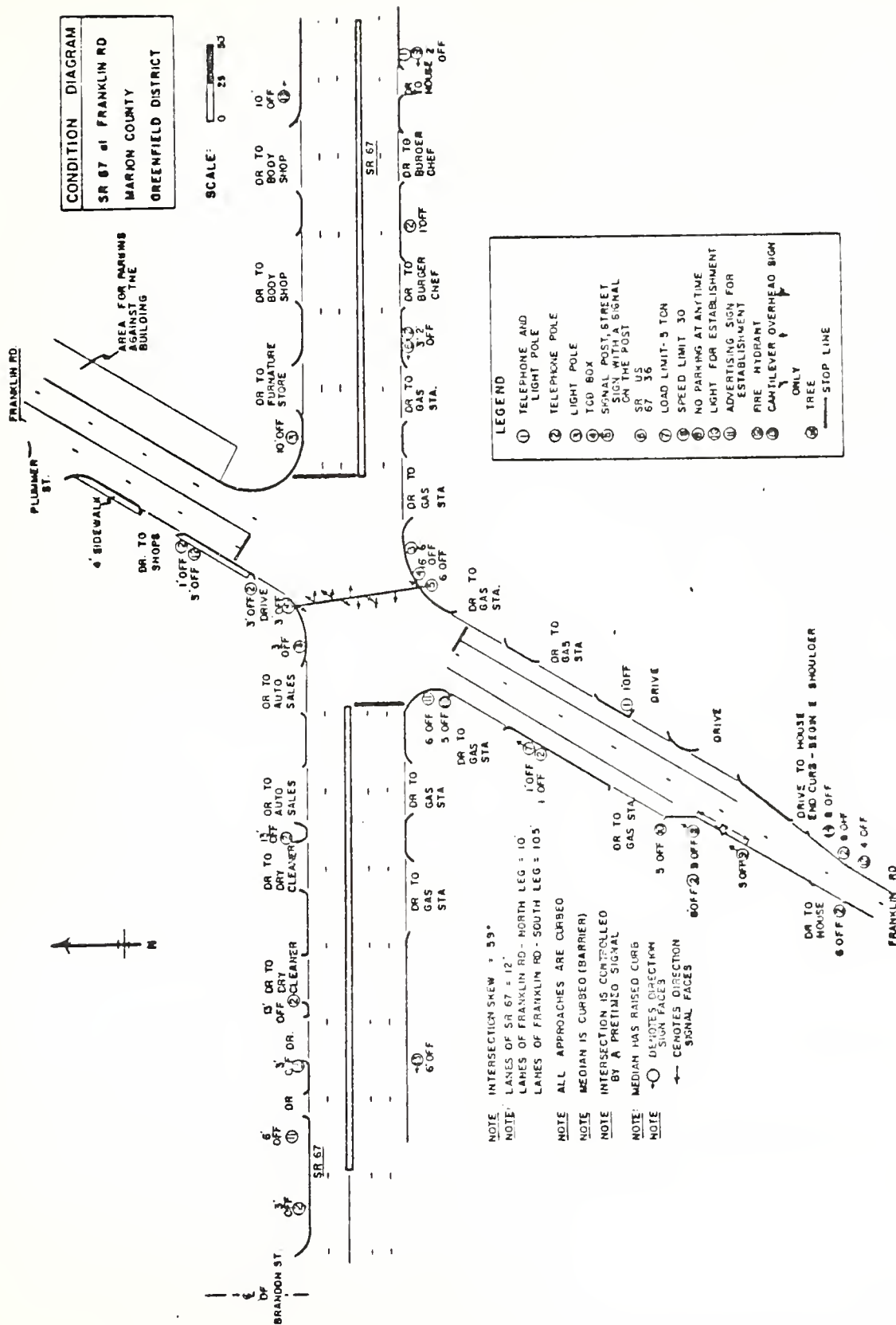


Northbound on Franklin Road at the Intersection of SR 67 at Franklin Road



Southbound on Franklin Road at the Intersection of SR 67 at Franklin Road

SCALE:  0 25 50



NOYF INTERSECTION SKEW = 59°

NOTE: LANES OF SR 67 = 12'

LANES OF FRANKLIN RD - NORTH LEG = 10

LANES OF FRANKLIN RD - SOUTH LEG = 105

NOTE ALL APPROACHES ARE CUBED

NOTE: MEDIAN IS CURBED (BARRIER)

NOTE INTERSECTION IS CONTROLLED

[illegible]

MULTI-STATE DIRECT

← REMOTES DISSECTION

ORIGINAL FACES

0
1
2
3
4
5
6

8

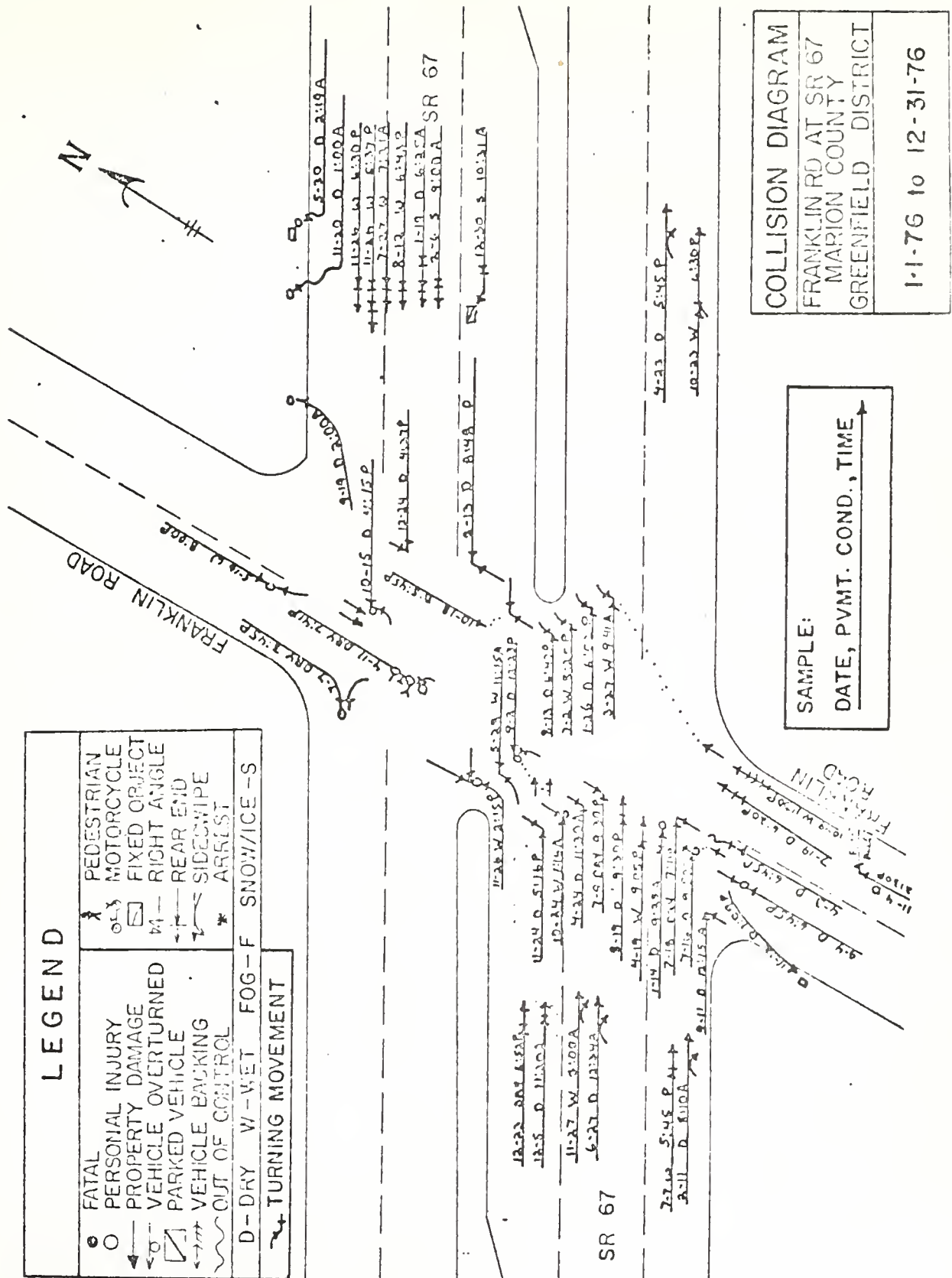
HC

●
●
●
●

1450

FRA

E



ACCIDENT

SUMMARY

LOCATION: SR 67 at Franklin Road

Marion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
50	29	21

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
10	39	1	19	1

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
5	8	1	L= 16 R= 2

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
10		1	7

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
33	14	3	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
6	7	4	9	7	11	6

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM		4	2	2	2	1			1		2	2	16
PM	3	4	1	2	7	5	1	3	1	1	2	4	34

ACCIDENT

SUMMARY

LOCATION: SR 67 at Franklin Road

Marion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
48	39	9

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
9	39		10	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
14	9	3	L= 9 R= 2

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
9			2

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
32	14	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
3	10	6	9	5	7	8

TIME FACTOR 1 NOT GIVEN													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	2					1		3	1		1	2	10
PM	2	5	9	4	1	6	2	2		1	1	4	37

ACCIDENT

SUMMARY

LOCATION: SR 67 at Franklin Road

Marion County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
48	28	20

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
11	37		16	

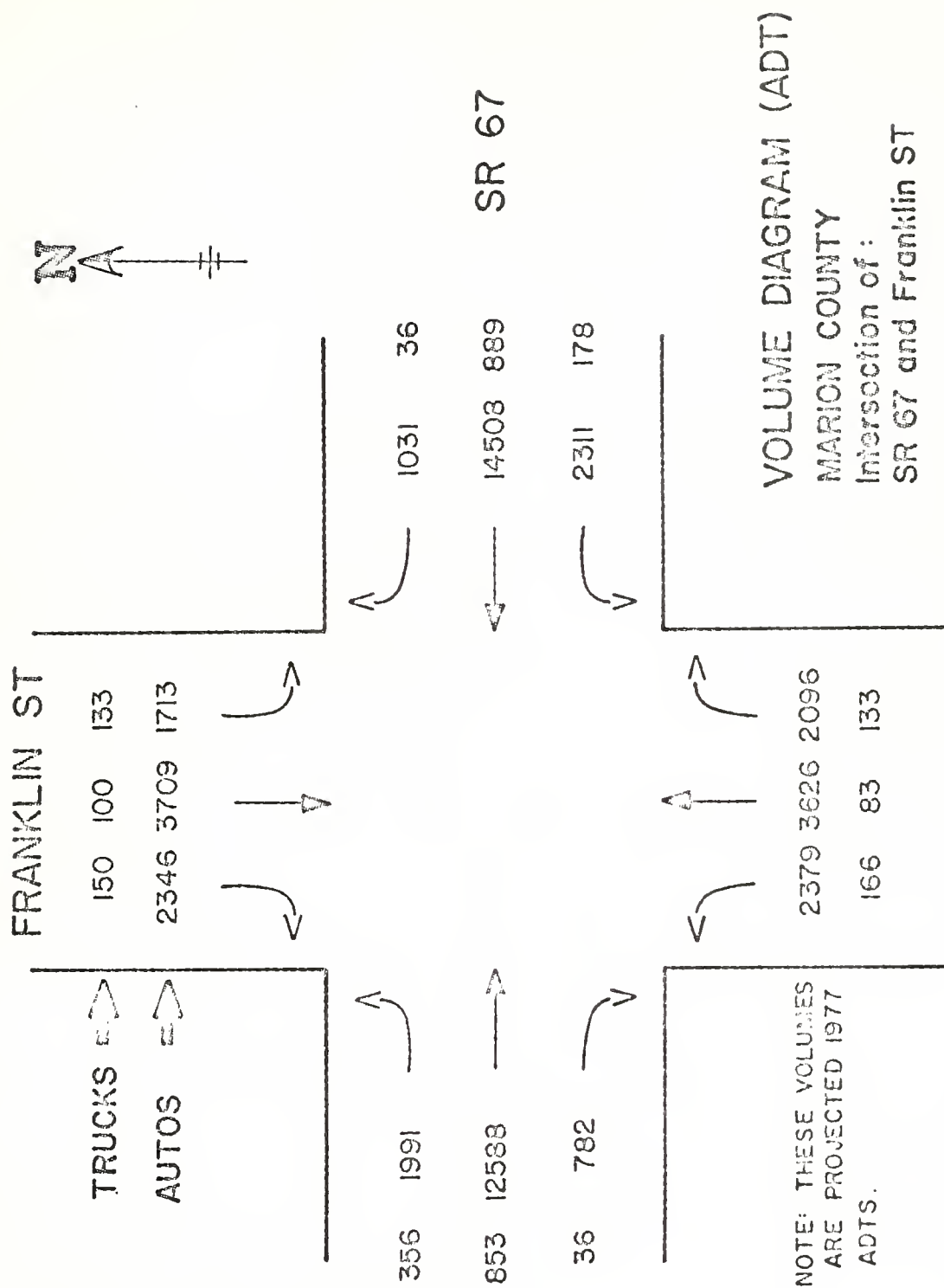
REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
14	11	2	L= 11 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
4	2		4

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
31	15	2	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
8	5	2	5	6	14	8

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	2	2	2	2			1	1	1	4	1	3	19
PM	1	1	2	1	2	5	8	2	3	3		1	29



APPENDIX F

DESCRIPTION, TEAM EVALUATION, AND FIELD DATA
FOR US 31 AT NATIONAL AVENUE

APPENDIX F: DESCRIPTION, TEAM EVALUATION, AND
FIELD DATA FOR US 31 AT NATIONAL AVENUE

Description of US 31 at National Avenue

The intersection of US 31 at National Avenue is in Marion County and in the Greenfield district. It is located approximately one mile North of I-465 on the South side of Indianapolis. The site can be considered in a suburban area.

US 31 is basically a six-lane undivided highway. National Avenue is a two-lane suburban street with right turn lanes at the intersection. The intersection is controlled by a fixed time signal positioned diagonally across the intersection. The speed limit on US 31 is 40 m.p.h.

Team Evaluation of US 31 at National Avenue

A meeting of the Indianapolis team was arranged but the ISHC central office traffic engineer was unavailable. A team consensus was formed as to the predominant accident types, possible causal factors and suggested countermeasures at this high accident location. The countermeasures are listed and not rank ordered.

Accident Type 1. Left Turning Movement

Cause 1. Left turning drivers on US 31 accepting insufficient gaps.

Countermeasure 1. Supplement the pavement markings on US 31 with an overhead sign with arrows designating lane usage.

Countermeasure 2. Construct opposing left turn bays on US 31 and add a left turn phase on US 31 if warranted.

Countermeasure 3. Eliminate National Avenue access.

Cause 2. Poor signal visibility.

Countermeasure 1. Reduce parking near US 31 at the Chevrolet dealership and the Ary-Way Shopping Plaza.

Countermeasure 2. Eliminate the Chevrolet dealership driveway close to the intersection on National Avenue.



Northbound on US 31 at the Intersection of US 31 at National Avenue



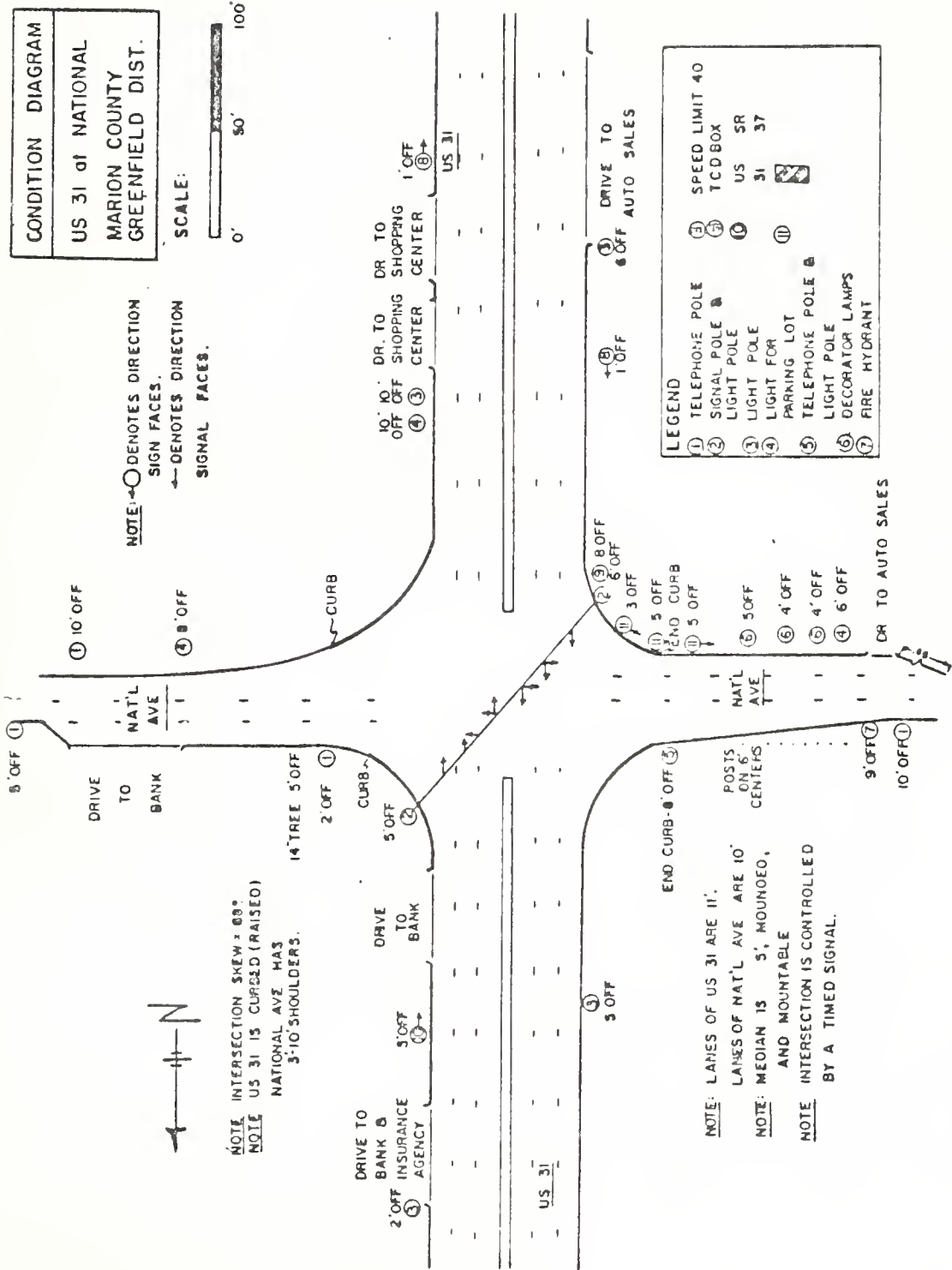
Southbound on US 31 at the Intersection of US 31 at National Avenue



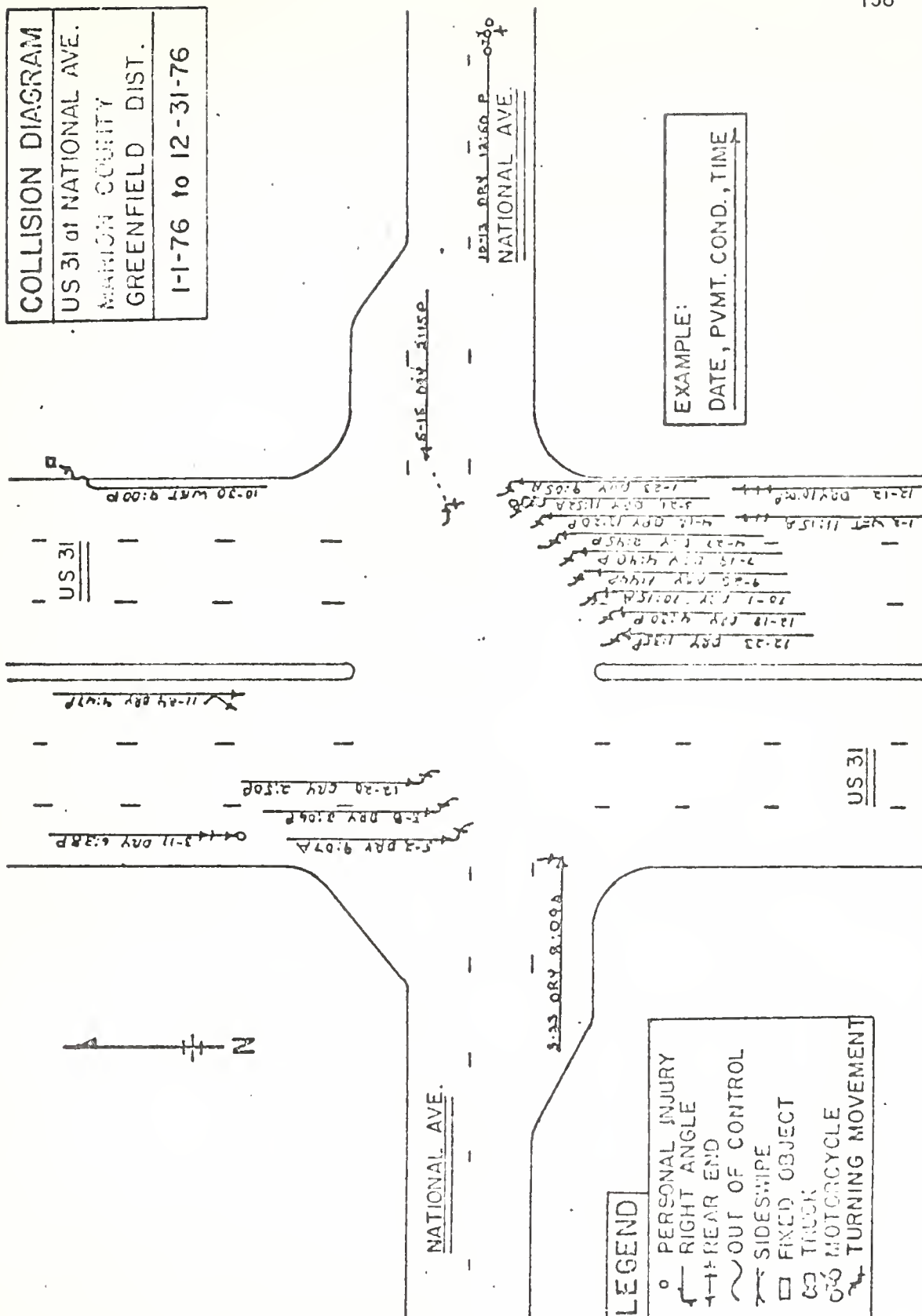
Eastbound at National Avenue at
the Intersection of US 31 at National Avenue



Westbound on National Avenue at
the Intersection of US 31 at National Avenue







ACCIDENT

SUMMARY

LOCATION: US 31 at National Avenue

Marion County

PERIOD: 1-1-74 to 12-31-74

DISTRICT: Greenfield

TOTAL ACCIDENTS	DAY	DARK
30	22	8

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
13	17		26	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
5	1		L= 22 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
1			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
25	4	1	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
2	3	6	6	2	8	3

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM	1					1			2	1		1	6
PM	3	4	2	3	1	2	1	4	3		1		24

ACCIDENT

SUMMARY

LOCATION: US 31 at National Avenue

Marion County

PERIOD: 1-1-75 to 12-31-75

DISTRICT: Greenfield

TOTAL ACCIDENTS
38

DAY	DARK
32	6

PERSONAL INJURY	PROPERTY DAMAGE	FATAL	INJURED	KILLED
16	22		28	

REAR END	RIGHT ANGLE	OUT OF CONTROL	TURNING MOVEMENT
12	2	1	L= 19 R=

SIDE SWIPE	HEAD-ON	PEDESTRIAN	OTHER
3			1

ROAD CONDITION			
DRY	WET	SNOW/ICE	OTHER
28	9	1	

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.
4	2	4	6	5	8	9

TIME FACTOR													
	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM										2	2	7	11
PM	2	5	6	3	1	4	2		1	1	2		27

ACCIDENT

SUMMARY

LOCATION: US 31 at National Avenue

Marion County

PERIOD: 1-1-76 to 12-31-76

DISTRICT: Greenfield

TOTAL
ACCIDENTS

20

DAY

17

DARK

3

PERSONAL
INJURY

3

PROPERTY
DAMAGE

17

FATAL

INJURED

4

KILLED

REAR END

3

RIGHT ANGLE

2

OUT OF
CONTROL

1

TURNING
MOVEMENT

L= 13 R=

SIDE SWIPE

1

HEAD-ON

PEDESTRIAN

OTHER

ROAD CONDITION

DRY

18

WET

2

SNOW/ICE

OTHER

SUN.

3

MON.

2

TUES.

4

WED.

2

THUR.

2

FRI.

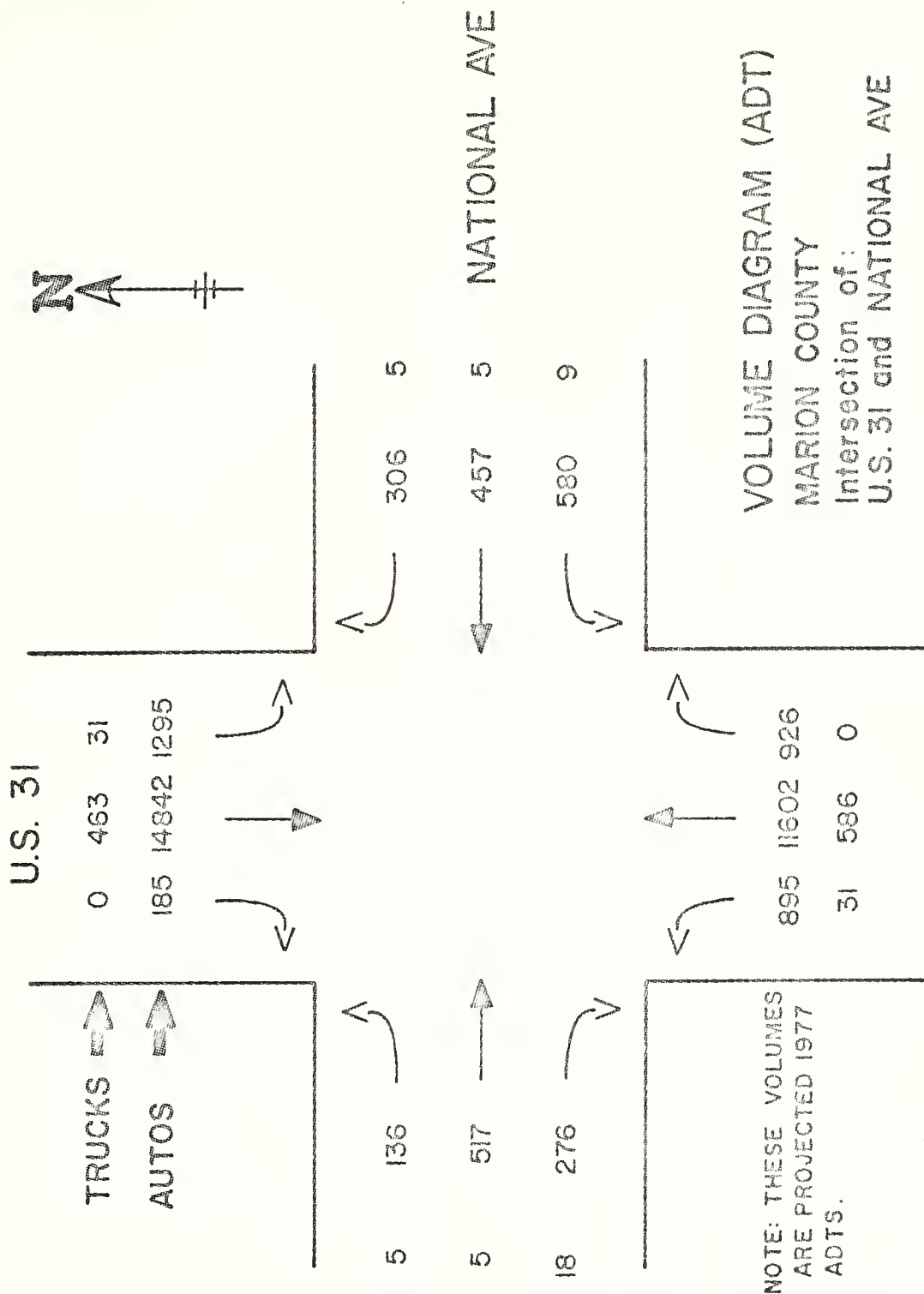
4

SAT.

3

TIME FACTOR

	12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL
AM									1	2	1	2	6
PM	2	2	3	1	3		1			1	1		14



COVER DESIGN BY ALDO GIORGINI